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THE ANCESTRY OF THE ELEPHANT.

By R. LYDEKKER.

THE two existing species of elephants—Asiatic and the African—are not only the largest, but also two of the most isolated among the animals of the present day. For although evidently allied to more typical hoofed mammals, like rhinoceroses, yet they are so different, that their relationship is evidently remote. Elephants are not unfrequently spoken of as "antediluvian" creatures; and if this term be regarded as equivalent to ancient, it is to a great extent a true statement of the case, for elephants and their progenitors, the mastodons, flourished during epochs which are old indeed in relation to human chronology, although modern from a geological standpoint. But "antediluvian" implies in this sense, if we mistake not, more than mere antiquity, and indicates the primitive structural characters of the animals to which it is applied. In certain respects an elephant is indeed decidedly primitive, or generalised, although in other ways it is just as specialised. In the possession of five toes to each foot, as well as in the structure of the wrist and ankle, elephants are indeed truly primitive. Not improbably, in spite of the fact that the opposite view has been suggested, the same is the case with regard to the peculiar conformation of their limbs, which differ from those of all living mammals. That is to say, in place of a marked angulation at the junctions of their different segments, the bones of each limb are placed almost vertically one above the other. This structural peculiarity is, of course, best displayed in the skeleton, although the straightness of limb is very perceptible externally, more especially in the case of the African species. The same feature characterises certain extinct mammals, of the approximate size of rhinoceroses; and from this it might be assumed that straight limbs were common to all the earlier animals. Such, however, is certainly not the case, the primitive carnivora, which come very close to being the ancestral type of all the higher mammals, having the limb-bones as much angulated as in a dog. From this it has been suggested that straightness of limb is a feature of comparatively modern origin, developed for the purpose of carrying the immense weight of an elephant. But, as mentioned later, the same feature apparently occurs in the early ancestors of the elephant, which were much smaller creatures; and if such a type be necessary in the case of an elephant, why is it not equally essential in that of such a huge animal as the white rhinoceros? As regards limb-structure, elephants are therefore apparently primitive.

On the other hand the trunk, or proboscis, of an elephant is a decidedly specialised organ, developed in correlation with the great length of limb and shortness of neck characteristic of elephants and mastodons.

Equally peculiar and specialised is the dentition of elephants, which consists of cheek-teeth, or grinders, and tusks. The latter, which are most fully developed in the males, and are preceded in infancy by a minute baby-pair, are confined to the upper jaw, and correspond to the front teeth of beavers, and not to the tusks of swine. Some of the mastodons had only upper tusks, but in others a pair was also developed in the lower jaw.

Elephants, like tortoises, attain a prodigious age, living to between one hundred and fifty and two hundred years, if not more. To attain this age, it is obvious that they must have teeth calculated to last much longer than those of other mammals, which become worn out within twenty-five years, or much sooner. In nature there are two ways by which teeth may be made to last longer than usual. They may either grow throughout life, like the incisors of the beaver, or their crowns may be abnormally heightened. Further aid in the same direction is afforded by retarding the appearance of the hinder grinders, so that they shall not come into use till those in front are nearly worn out; this being merely an exaggeration of what occurs in ourselves, where the wisdom-teeth do not come into use until well on in mature life.

In modern elephants both plans have been followed; the first in the case of the tusks, and the second in that of the cheek-teeth, or grinders. During life six pairs of grinders are developed in each jaw of an elephant; the first pair of each series being small and almost functionless, while the last is of enormous size, and does not make its appearance till late in life, although the exact date of its coming into use (as in the case of the other teeth) has yet to be ascertained. Each tooth consists of a number of tall, thin, transverse plates, closely packed together, and comprising layers of different hardness, so that when worn the grinding surface displays a series of low ridges, forming an excellent millstone. The number of these plates increases from the first to the last tooth in both species; but they are taller, thinner, and more numerous in the Asiatic elephant and its relative the extinct mammoth, than in their cousin the African elephant. As the teeth in the fore part of the jaws are gradually worn away, their stumps are pushed out by those next behind; the whole series coming

up in the jaws in the arc of a circle. By this arrangement it results that there are never more than two teeth in use at any one time on each side of both jaws; while in old age there is but a single pair of cheek-teeth in each jaw. When these last become so worn down as to be useless, the elephant must die; although it is probable that, in most cases, death takes place before such a completely toothless condition is reached.

It is thus evident that modern elephants, far from being primitive as regards their dentition, are highly specialized creatures. The nearest approach to this remarkable mode of dental succession is presented, among living mammals, by the manati, or sea-cow, in which an almost endless series of cheek-teeth come up one behind another in the jaws as those in front are worn out and discarded. In connection with this resemblance in the mode of succession of the teeth of the manati to the condition obtaining in the elephants, it is important to notice that the ancestral elephants, or rather proboscideans, appear nearly related to the progenitors of the manati. In the early ancestral forms of both groups the cheek-teeth were of a normal type as regards their mode of succession, the whole series being in use at once. Consequently, the peculiar mode of succession occurring respectively in the modern elephants and manatis must have been independently acquired in each. Cases of such parallelism in development are common enough in groups of widely diverse origin, but the occurrence of the phenomenon in groups closely connected is a very remarkable circumstance.

As already mentioned, the component plates of the cheek-teeth of the African elephant are fewer in number

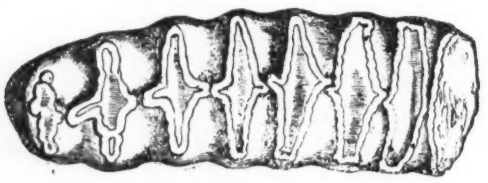


FIG. 1.—Grinding Surface of a Lower Molar of the African Elephant.

and shorter and thicker in form than those of the Asiatic elephant and mammoth. Extinct forms show, however, a complete transition in this respect between the two types. On the other hand, there is a gradation in dental structure from the African elephant towards the extinct group of stegodons, or ridge-toothed elephants, of which the fossilised remains are met with abundantly in late Tertiary formations from India and Central Asia to Japan and Java, but have hitherto been found in no other part of the world. In these ridge-toothed elephants, as their scientific name of stegodon implies, the plates of the cheek-teeth are reduced to low transverse ridges, recalling the pitch of a slate roof. Each ridge is separated from its neighbour by an open V-shaped valley; and the number of ridges in each tooth is much less than in the corresponding tooth of the true elephants. A further peculiarity is to be found in the circumstance that in the third, fourth, and fifth pairs of teeth the number of ridges is nearly the same. This equality in the number of ridges in their "intermediate molars," as they have been designated, forms a connection between the ridge-toothed elephants and the mastodons.

Owing to the millstone-like surfaces formed by their cheek-teeth, modern elephants masticate their food by a backwards-and-forwards motion of their jaws. Obviously, however, such a movement would be incompatible with transverse ridges separated by open valleys on the summits of the cheek-teeth; and it is consequently evident that the ridge-toothed elephants, as well as their predecessors the mastodons, masticated their food partly by a champing and partly by a sideways movement of the jaws. Such a difference in the method of mastication is noticeable between the modern and ancient representatives of several groups of hoofed animals—notably in the case of the horse as compared with its progenitors.

One of the ridge-toothed elephants, as well as another extinct Asiatic species more nearly allied to the African elephant, displays a peculiarity in its dentition which tends to show the derivation of the group from animals of a less specialised type. To explain this it must be mentioned that the whole six pairs of cheek-teeth developed in each jaw of a modern elephant, from childhood to maturity, correspond with the baby-molars *plus* the permanent molars of the human dentition; the only difference as regards number being that the elephant has three of these baby-molars, whereas the human infant possesses but two on each side of both jaws. Consequently, the elephant possesses no representatives of the premolars or bicuspids which vertically replace the baby-molars of the human infant as they become useless. That is to say, except in the case of its tusks, an elephant has no vertical replacement of its teeth; in other words, it has lost the premolars common to other animals.

From the stegodons, or ridge-toothed elephants, it is but a step to the mastodons, which are mainly distinguished by the inferior height and smaller number of their transverse ridges. In the "intermediate" molars of one type of mastodon, the number of ridges is four on each tooth, although, as a rare abnormality, there may be five. Mastodons show a step away from elephants in the fact that there may sometimes be portions of three cheek-teeth in use on the same side of one jaw at the same time; this being due to the smaller size of the teeth.

Here it is important to notice that the species of mastodon which presents the nearest approximation to the stegodons—namely the broad-toothed mastodon—occurs in the same countries as the latter, that is to say in Northern India, Burma, &c. In this species there were tusks only in the upper jaw, and the lower jaw terminated in front in a short spout. As regards both these features,

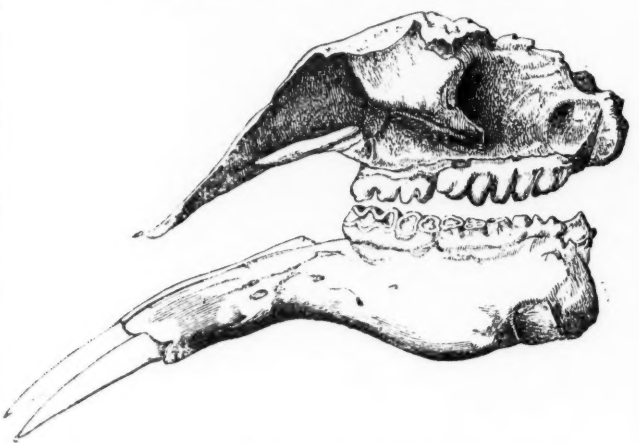


FIG. 2.—Imperfect Skull of a four-ridged Mastodon, showing only two molar teeth (the penultimate and last) in use on each side of both jaws. (From a specimen in the British Museum.)

the North American mastodon, which appears to have survived into the human period, was a very similar

animal, but each of its "intermediate" molars was three-ridged.

A more primitive type is indicated by the four-tusked mastodons, in some of which the "intermediate" cheek-teeth are three-ridged, while in others they are four-ridged. In most or all the members of this group the lower pair of tusks are short, and project from the extremity of a long trough-like extension of the lower jaw. Moreover, in a skeleton of *Mastodon angustidens* now mounted in the Paris Museum, the upper tusks are bent downwards so as to cross and project far below those of the lower jaw. As regards its head, this mastodon, which is one of the oldest of its kind, occurring in the Miocene strata of the Continent, must have been very different looking to an elephant. To correspond with the trough-like elongation of the lower jaw, the upper part of the muzzle was probably prolonged in proportion; and consequently the proboscis was relatively short.

Contemporaneously with the species last mentioned lived another elephant-like creature—the dinotherium—characterised by the presence of a pair of downwardly-bent tusks in the lower jaw, and the more ordinary structure of its cheek-teeth, of which all five pairs were in use at the same time. These teeth recall, indeed, to a considerable extent those of a tapir, the two hinder pairs in each jaw being surmounted with a couple of transverse ridges. The tooth in advance of these has, however, three ridges, like the "intermediate" molars of some mastodons, and the same is the case with the last milk-molar, which in a young animal is situated immediately in advance of the permanent three-ridged tooth. In the adult the three-ridged milk, or baby-tooth, is, however, vertically replaced by a successional tooth of simpler structure, as in ordinary mammals. In build, the dinotherium was probably very like a short-trunked elephant; it may, perhaps, have obtained its food by wading mid-leg deep in lakes and marshes, and thus bringing its mouth within reach of the water-plants.

Although the dinotherium tends to connect mastodons and elephants with ordinary hoofed mammals, so far as its cheek-teeth are concerned, yet the peculiar form of its lower tusks, and the absence of weapons of this nature in the upper jaw, show that it is not the ancestral type of the former. On the contrary, elephants and mastodons on the one hand, and the dinotherium on the other, form branches of a common ancestral stock which till lately was quite unknown. Indeed, the seemingly sudden appearance of the proboscideans, in the form of both these branches, in the Miocene strata of Europe, had long been one of the puzzles of palæontology, and remained so till light was thrown on the subject from an unexpected quarter.

The region whence this light has come is the Fayum district of Egypt, from the Lower Tertiary, or Eocene, deposits of which remains of unknown forms of vertebrates have been recently exhumed. Among these, are jaws and teeth of a small and primitive mastodon, related in many respects to *Mastodon angustidens*, of which it may have been the ancestral form. In this connection it may be mentioned that remains of the latter species have been met with at Moghara, to the north-west of the Fayum.

The lower jaw of this early mastodon resembles that of *M. angustidens* in the elongation of the trough-like anterior portion, and also in the cheek-teeth, which are three-ridged. There is, however, the important difference that the last molar resembles those in front of it in the number of its ridges, in place of having four ridges, and also that the whole five cheek-teeth are in use at once. Nor is this all, for the anterior two of these teeth are premolars, instead of milk-molars; that is to say, they have vertically replaced deciduous predecessors. Clearly, then, this Egyptian Eocene mastodon—palæomastodon, as it is called—is a proboscidean but little removed as regards the characters of its cheek-teeth from ordinary hoofed mammals, although in the production of the lower jaw, and the reduction of the front teeth to a single pair of tusks in each jaw, it resembles typical mastodons. Apparently, the limb-bones conform to the ordinary proboscidean type, from which it may be inferred that the legs were constructed in much the same manner as in an elephant. The fact that such a comparatively small animal has a conformation of limb similar to that supposed to have been developed for the purpose of carrying the enormous weight of an elephant, throws doubt on the theory of the secondary origin of this type of limb-structure to which allusion has been already made.

An earlier formation in the Fayum district has yielded remains of an allied animal—the mœritherium—so named from the ancient Lake Moeris, near the bed of which it was discovered. This creature, which was about the size of a tapir, departs widely from a mastodon, and still more

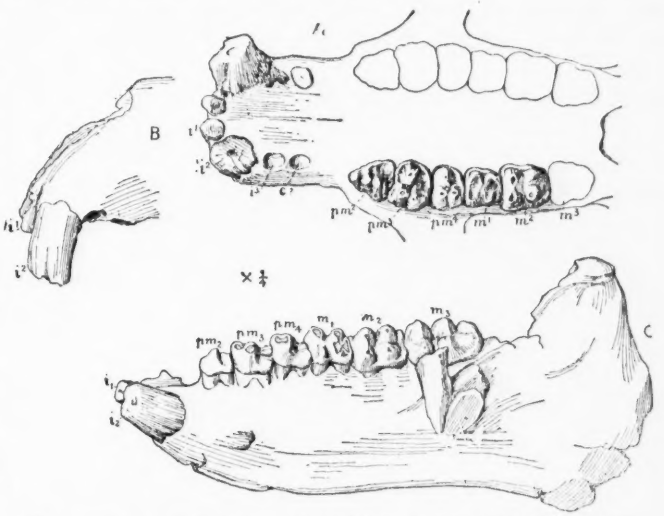


Fig. 3.—The Imperfect Skull (A and B) and Lower Jaw (C) of the forerunner of the Elephants (the Mœritherium). i^1—i^3, incisors; c, canine; pm^2—pm^4, premolars; m^1—m^3, molars. (By permission of Dr. C. W. Andrews, the describer and joint-discoverer of the ancestral proboscideans.)

from an elephant. Nevertheless, there are many features in its structure pointing to the conclusion that it is an ancestral member of the proboscidean stock. Each jaw is furnished with six pairs of cheek-teeth, all of which are in use at the same time; the series consisting of three pairs of premolars and as many molars. The latter are not unlike the corresponding teeth of many early-hoofed mammals—some of the extinct pigs, for instance—and, with the exception of the last in the lower jaw (which is three-ridged), carry two transverse ridges. They display, however, a tendency to the development of three ridges, thus foreshadowing the mastodon type.

Very remarkable are the front teeth. In the upper jaw these comprise four pairs, of which the second is much larger than either of the others. The first three pairs correspond to the incisors of a pig; while the fourth pair represent the canines. Obviously the three small pairs of

teeth are in course of elimination, while the large pair represent the tusks of the mastodons, which are thus shown to correspond to the second of the three typical pairs of incisors. In the lower jaw the canines and the third pair of incisors have disappeared; while of the two remaining pairs, the first are small and functionless, but the second are large and project forwards in a manner recalling the lower tusks of the mastodons, of which they are the forerunners.

Although it would be out of place to discuss its proboscidean features here, it may be mentioned that this skull lacks the great elevation characteristic of the elephants, but has the brain-cavity relatively large. In the former respect there is an almost complete gradation from the elephants through the mastodons to the mœritherium. Obviously the latter animal must have been very short-lived in comparison with an elephant; and it is also evident that it was either trunkless or furnished with a rudiment of proboscis.

The limb-bones are not yet fully described, but it is suggested that they resembled those of the extinct American unitatherium in being placed vertically one above another. If this be so, the theory that elephants acquired their straight limbs in order to support their great weight will certainly not hold good.

The discovery of these new forms has shown that elephants and mastodons, in place of forming a group of unknown origin, are the descendants of small, short-lived and trunkless animals, with a type of dentition not very far removed from that characteristic of hoofed mammals in general. And it is further evident that elephants, in place of being primitive, are a very highly specialised type. Moreover, the absence of remains of forerunners of the mastodons from the Tertiary formations of Europe and Asia, affords evidence that the evolution of the mastodons took place in Africa.

MURRAY AND CHRYSTAL ON "SEICHES."

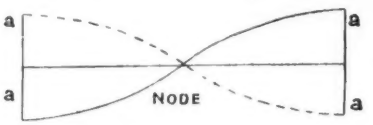
By DR. J. G. MCPHERSON, F.R.S.E.

THE other evening two very interesting papers were read to the Royal Society of Edinburgh on "Seiches," or "standing waves," by Sir John Murray and Prof. Chrystal, the former on the observations and the latter on the theory.

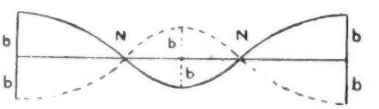
Besides the ordinary forms of waves in fresh-water lakes there are standing waves which have only recently been carefully observed and studied. It is curious to notice that though there is no longitudinal or transverse displacement, there is an oscillatory movement of the whole body of water, so that when at one end of the lake the water is raised by a wave of several inches there is a corresponding depression of the water at the other end.

Forrel, the distinguished authority on waves and their motion, noticed the phenomena in the Lake of Geneva, but he could not accurately account for these. These "seiches," as the standing or undisplaced waves of the entire mass of water are now called, have been recently observed in Como and other Continental lakes; and Prof. Henry has observed a raising of Lake Erie in America to the extent of eight feet, quite independent of the waves caused by strong winds. Sir John Murray and his assistants, Dr. Johnston and Messrs. Murray and Garrett, during last summer, when engaged in bathymetrical observations in Scottish fresh-water lochs, noticed some curious wave phenomena, but their instruments were not sufficiently accurate to produce satisfactory results. However, they have now secured the excellent instrument made in Geneva, which has also been ordered from different stations in Japan and America, and they hope this summer to make more accurate observations, so as to afford Prof. Chrystal sufficient correct data for mathematical investigation.

Mr. E. Maclagan Wedderburn illustrated the different forms of standing waves by an ingenious apparatus; of course the depth of the water in the rectangular trough was far deeper in proportion to the length of the trough than is found in natural lakes; but it brought out to the eye the principles of the motions. In one case the wave of the mass had only one node in the centre, where the bottom of the trough was level. While the water was in motion on both sides of the node, the one part raised, the other part depressed at the same moment, the water at the node was perfectly still. By another arrangement of difference of level in the base, Mr. Wedderburn managed to produce wave motion with two nodes where the water at two points on the surface was still, and the waves were plainly seen in the three remaining portions. By continuing the arrangement he produced several nodes. Thus seiches are uninodal, binodal, and plurinodal, according to the structure of the base of the lakes. They



(*a*) represents a uninodal wave, the dotted part being the complement.



(*b*) represents a binodal wave, the dotted part being the complement.

are rhythmical, and similar to the nodal points of sound-waves. By an ingenious adjustment of the apparatus, Mr. Wedderburn was able to produce a uninodal wave and a plurinodal wave by two sets of motions at the same instant, and a most curious result was produced. Again, by making certain alterations in the base, the nodes were made to occur nearer one end of the trough than the other.

Attacking the general solution by Bessel's formula, Du Boy's period (as guessed by Newton), Kelland's formula, Laplace and Merian's formulæ, Prof. Chrystal has come to some, so far, satisfactory theoretical results; but he is waiting for physical observations of the seiches in the lakes before he goes further, as it would be a mere waste of time so far as any practical and useful results could be obtained.

Prof. Chrystal made some beautiful pendulum experiments to illustrate the oscillatory changes caused by a sort of physical sympathy. From this he concluded that though the surface of Lake Erie is often troubled by seiche motion to a height of eight feet, deep down the water is motionless. The matter is still in its infancy, but this note will indicate the lines on which these observers and calculators are proceeding.

WIRELESS TELEGRAPHY AND WEATHER FORECASTING.

By ARTHUR H. BELL.

WIRELESS telegraphy is doubtless destined to play an important part in furthering the advancement of many projects connected with the life of the nation; but it may

be doubted whether any of the enterprises to which it may be harnessed, as it were, will prove so interesting as when it comes to be employed in the business of forecasting the weather. At present the weather prophets are doing the best they can with the ordinary method of sending telegraphic messages, and considering the many obstacles in the way, it must be conceded by any unbiased critic that they do very well indeed. The mere fact, however, that there are so many miles of wire, and so many post offices, between the officials at the central office, where the forecasts are prepared, and their observers who send them the daily reports of the weather, is a serious hindrance to progress, and it will be a happy day for the weather prophets when these intermediaries are abolished.

The general methods by which a modern forecast of the weather is produced have, to many people, an air of mystery, and to the uninitiated few things seem so mysterious and complicated as a weather chart. Most countries nowadays have established offices where such charts are daily compiled, and in all of them the method of procedure is the same. The object aimed at is to obtain a general notion of the state of the weather at a given hour over a large tract of country. To this end a large number of observatories or stations are established in many different localities, it being the duty of the observers to make reports of the weather two or three times a day. The information specially asked for refers more especially to the height of the barometer, to the direction and force of the wind, the state of the sky as regards cloudiness, the temperature of the air, and the amount of rainfall. During a great number of years these observations have been taken in the British Isles three times a day—at 8 a.m., 2 p.m., and 6 p.m.

Now, in order that this information may be of the greatest amount of service, it is important that it should arrive at the head office promptly. The messages accordingly are forwarded by telegraph, so that at the earliest opportunity they may be plotted on to a chart or map. With this weather chart in front of him the official weather forecaster is accordingly informed as to the places where the barometer is rising and where it is falling. On this information he bases his forecasts, and issues, if need be, his warnings as to approaching storms and gales. The reports, moreover, that are telegraphed at other times during the day greatly help as regards giving information concerning the direction in which any storm may be travelling. For instance, the chart may show that a storm has arrived on the west coast of Ireland, and the important thing to know is whether it seems more likely to move north-eastwards across Scotland or south-eastwards across England. It is indeed at such a time as this that the most difficult problems arise, and the mistakes made by the weather prophets are generally due to the fact that the storms suddenly move off in an unexpected direction. Speedy and prompt information from the observing stations is therefore of the highest importance.

Something of the difficulties of the case are understood when the mechanism, so to speak, of one of these revolving storms, cyclones, or depressions, as they are variously called, is examined. Such aerial eddies may be likened to the dimples seen in every running stream of water, for not only have they a rotatory movement, but, like the dimples, they also travel onwards. Cyclones, it should be remarked, vary very greatly in size, and their diameter may be anything from a few yards up to a thousand miles. The smallest of them may be seen at any street corner on a windy day, and, indeed, a little time spent in watching these miniature whirlwinds will give a very fair idea of the causes which produce the larger atmospheric cyclones. Intermediate between the small eddies and the full-grown storms are the whirlwinds and dust storms which career across many of the deserts and arid plains; while in this same category are also to be included the waterspouts that spring up over the sea and some of the larger lakes. All these phenomena are nearly related, and in each there is a rotatory as well as an onward movement. A very fair representation of a revolving cyclone may be obtained by turning a stick very quickly in water, and it will be noticed that the faster the water is made to revolve the deeper does the dent or hollow in the water become. There is a similar relationship between the depth of a cyclone and the velocity of the winds blowing around it. At the centre of every storm the atmospheric pressure is greatly deficient, and the barometer falls to a low level. This pressure increases outwards from the centre of the system, the barometer rising higher and higher towards the outer edge of the storm. Now, when the slope from the outside edge to the centre is very abrupt, like the descent to certain valleys, the barometric gradients are said to be very steep, and it is at such times as these that the wind attains its greatest force. All these, then, are matters that are clearly set forth on a weather chart, and with this information before him the weather forecaster can readily see whether the storm is a severe one, or, in other words, he is able to see whether the atmospheric vortex is very deep.

It is, however, when the attempt is made to forecast the future movements that the difficulties begin, and it is at this point that wireless telegraphy would prove of the greatest assistance to the hapless weather prophets. A few years ago many of the newspapers published storm warnings sent from America, the idea being that storms observed to be setting forth from the American shores would eventually reach the British Isles or some other part of Western Europe. Commonly, the warnings stated that between such and such dates a storm might be expected to show itself on the French, British, or Norwegian coasts, the margin both as regards time and place being large. But many of the storms never arrived, having possibly blown themselves out during their journey across the Atlantic, while others, instead of taking a day or so over the voyage across, would loiter about for days, so that the storms failed to put in an appearance or arrived in unexpected places at unexpected times. The experiment of sending the storm-warnings was, however, an interesting one, for it recognised the fact that these cyclones make long journeys without losing their identity, and from this point of view these warnings therefore had their uses.

Contrasted with the weather forecasters in America, the British officials are placed at a great disadvantage, for instead of having a wide continental area to the westward of them, they are bounded by the Atlantic Ocean. All storms, owing to the deflecting movements of the earth as it rotates on its axis, travel from west to east, so that it is the desire of all weather forecasters to obtain early and prompt information from as many places to the westward of them as possible. In this respect it will be seen that a forecaster, say at Washington, is well situated, for to the westward of him he has many observers who send him all the latest information, so that it is much easier to trace the daily progress of a storm as it blusters across the country. But the British forecasters are in much worse case, for they often do not know of the existence of an on-coming storm until it has actually appeared on the west coast of Ireland. The problem, therefore, that has always presented itself has been as to the best means to be adopted for finding out what was happening away out in the Atlantic.

XUM

At present the earliest information that can be obtained concerning approaching storms from the Atlantic is received from the observing station at Valencia, in the south-west of Ireland. Now, on more than one occasion, it has been suggested that something might be done in the way of anchoring a vessel or a sort of floating meteorological observatory two or three hundred miles off the coast of Ireland. The opinion has been expressed that there are shoals and shallows that would afford a suitable anchorage; and, indeed, so much enamoured with this scheme were certain enthusiastic meteorologists, that they went so far as to design a floating observatory wherein the observers and the necessary instruments could be housed and floated in mid-ocean. These suggested observatories resembled nothing so much as a gasometer, this being the shape favoured by their designers; and the idea was that the observers would be connected to the shore by a telegraphic wire along which messages could be sent concerning the state of the weather. But in order to carry out this scheme a very large amount of money would be required, and since, moreover, there was apparently no great rush of observers eager to be shut up in the floating observatories, the plan has never been adopted, and it is to be numbered among the things that might have been. It has indeed been suggested that such floating gasometers would with difficulty be kept in position, the chances being that the observers would periodically find themselves bumping about on the coast of Ireland signalling for the steam tug to come and put them in position again.

Another idea that was actually tried was to obtain reports from the steamers arriving at some of the American ports as to the kind of weather they had experienced during their journey across the Atlantic. It was considered that, by thus gaining early information as to any cyclones that might be disporting themselves over the Atlantic, there would be time to telegraph to the weather forecasters in England and warn them that such storms had been encountered. Difficulty, however, was experienced in collecting this information, for, commonly, when a ship arrives in port, the first business of a captain is to see to the landing of his passengers and the discharge of his cargo, there being, as a rule, little time to spare for writing out and dispatching weather reports. Excellent, therefore, as this scheme for gathering information appeared to be, there were difficulties in the way of its full development, and it cannot be said that it proved of any great advantage.

But it is from these swiftly-moving steamers that, perhaps, after all, the weather prophets may, in the near future, derive the much-desired information concerning the weather over the Atlantic. By means of wireless telegraphy, ships are now sending messages to lighthouses, and are in touch with reporting stations scores of miles away. Moreover, it seems clear that ere long messages will be sent over hundreds of miles of space, and when this becomes an every-day occurrence, the weather forecasters will get their chance. Steamers, for instance, leaving Queenstown and Liverpool, may be kept in touch throughout the greater part, and it may even be during their entire journey across the Atlantic. In the messages that would pass from the ship to the British shores there might easily be included information concerning any storms that were encountered on the way. These particulars would refer especially to the intensity of the storm, and the date and place where it was met with. Doubtless, before very long, all the great steamers will be fitted with the wireless telegraphy apparatus, and it will be seen that when the system is in full working order the problem as regards receiving intimation of the approach of storms from the westward will be solved.

Moreover, the further development of wireless telegraphy may not only be expected to prove of use as regards collecting weather information from the Atlantic, but on shore also it will prove of incalculable advantage to the weather prophets. As already mentioned, there is often delay in sending the daily observations of the weather along the ordinary telegraph wires, the arrangements at many of the local post offices often hampering the prompt despatch of important reports. Telegraph offices, in many places, are open only at certain definite hours, and no matter how important may be the message an observer may have to forward to the head office, it can only pass along the wires at certain hours, a circumstance that often greatly handicaps the officials responsible for preparing the weather forecasts.

But not only does this apply to the receipt of the messages, but it applies also to the issue of the storm warnings. When the officials at the central weather office have come to the conclusion that a storm is about to burst over the country, it is, of course, part of their work to send out storm warnings to the seaports, where, as soon as the warning is received, the storm signals are hoisted. Now these warnings have also to be sent by telegraph, and it will be understood that at many of the country and outlying post offices the messages can only be received and delivered up to a certain hour. Supposing, therefore, the weather forecasters were to sit up all night observing the weather, there would, with present arrangements, be no advantage in doing so, because so long as the warnings have to be sent along a wire it is impossible now to get any messages through to those whom they may concern. But here, again, it will be seen that if the wires and the post offices were done away, and communication between the observers and the central office and between the central office and the various seaports were established by means of wireless telegraphy, an added usefulness would be given to the storm warnings and the weather forecasts.

At times, too, it happens that during stormy weather the present telegraphic system breaks down entirely, it being no uncommon thing during a severe snow-storm for telegraphic communication between different parts of the country to be interrupted during many days together. In such circumstances as these, not only is it impossible for the observers to forward their weather reports to the head office, but it is equally impossible for any storm warnings and weather forecasts to be dispatched along the telegraph wires. These are doubtless irritating circumstances that the weather forecaster of the future will know nothing about, for with wireless telegraphy at his service his messages will come and go, no matter if storms may be raging and the whole country buried deep in snow.

There is, therefore, from the weather prophet's point of view, much to hope for from wireless telegraphy, and on the day that the first storm warning is issued by this means, an important epoch in the history of the weather will begin. At present many storms arrive unheralded, but with this new agent at his service, the weather forecaster will keep in touch with them throughout their whole course, and they will be kept under observation from New York, it may be, and right across the Atlantic Ocean to the coast of Norway. Recognising, therefore, the many advantages they will gain from its future developments, it will readily be imagined that those whose business it is to forecast the weather await with interest the improvements that will assuredly continue to be made in wireless telegraphy.

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THE DARK HEMISPHERE OF VENUS.

By B. W. Lane.

Although the object of this paper is to add one more theory to the many which have been formed to account for the visibility of this part of the planet Venus, I think I may be excused if I first run over some of the principal theories which have been previously put forward.

The phenomenon itself may be described as follows:—Now and then the part of the planet not lit by sunlight has been observed to shine with a faint light, exactly similar to that emitted by the night side of the crescent moon. This illumination, however, unlike that on our satellite, which is constant, is intermittent, sometimes not appearing for months together, or even longer, even in the best telescopes, and at other times being apparent at the first glance, and on rare occasions being bright enough to have been once or twice visible in the daytime.

There is no satellite to illumine Venus in this manner; the earth is thousands of times too faint at that distance to produce it; the fact that the faintly-lit side always appears smaller in radius than the bright portion, precludes the possibility of its being an optical delusion due to the prolongation in the eye itself of the horns of the crescent. It is therefore, apparently, as Webb calls it, an "inexplicable phenomenon."

All theories having for their basis the suppositional existence of intelligent inhabitants on Venus may, I think, be left over until every other method has been found to fail.

The two theories which are at present most generally considered to be most likely, explain the appearance: the first by supposing auroræ of great brilliancy on the planet, and the second by supposing the atmosphere of Venus to be capable of refracting the sunlight sufficiently to suffuse all the dark side of the planet with a perpetual twilight.

In answer to the first of these theories it may be said that in the first place we can scarcely fairly suppose auroræ of sufficient brightness on Venus, as Mr. Proctor points out, and secondly, auroræ are usually found to occur on such occasions as when a sunspot crosses the solar meridian, and, therefore, if this were the explanation, illuminations should take place when the sun is spotted, rather than at other times, yet no such coincidence has been observed.

Against the second, the objection may be urged that if the dark side is lit up by refracted sunlight at one time it should also be so lit up at another, and even supposing such enormous changes of atmospheric conditions as are necessary to account for the occasional nature of the phenomenon, the terminator is just as sharp and exactly defined on days when the dark side is visible as when the dark side is invisible, whereas if the above were the true explanation, at these times the light and dark sides should fade almost imperceptibly into each other.

The theory which I here intend to put forward attributes the appearance to a factor in the lighting of the sky which has hitherto escaped recognition. I refer to meteor swarms.

Now it seems to me that the brilliant illuminations of the sky caused by the Leonids in the old days before they lost their way, should have been almost if not quite sufficient to make the night side of earth very faintly visible from, say, Mars. Personally I never had the good fortune to see the Leonids in 1866, and still less so in 1833, but when I hear on the authority of Humboldt and others that the swarm was sometimes so thick that at times there were as many meteors visible at once as ordinary stars, and when I compare this with the meteor which I can see any night after ten minutes' watching, it seems to me that the light given out, even after every discount has been taken off for very natural exaggeration, must have been very considerable. When I further read that at some places in 1833 people were wakened up, although the blinds were down, by the flickering light thrown by these meteors, I begin to think that this light must have been not only far stronger than moonlight, but quite enough to make the dark side of our planet visible to other members of our system. Persons who have seen the Leonids thirty-five years ago will, of course, be able to correct any mistaken impression I may have received, out of their own experience.

I think, however, it will be admitted that as there are probably, nay, certainly, larger meteor swarms than the Leonids wandering through space, swarms exceeding the Leonids in density probably as much as the Leonids exceed the ordinary swarms, it is practically certain that these swarms if they collided with a planet having an atmosphere such as Venus undoubtedly has, would be able to light it up quite sufficiently to render it easily, if not strikingly, visible.

The question, then, is, are we justified in supposing that Venus is lit in the same way and by the same means as the earthly night skies have from time to time been illuminated?

The average brightness of meteors entering the atmosphere of Venus will, by reason of their greater average velocity, be about a-third greater than that of meteors entering the earth's atmosphere. Therefore a swarm like the Leonids acting on Venus—other conditions such as inclination of orbit, etc., being equal—would produce about four-thirds the illumination which it produces here. I think, therefore, there need be little doubt that there are meteor streams known to us capable of producing this illumination, or something like it.

The matter, however, does not rest here. The question now is, how often do we meet such streams, and, above all, how often do we meet streams which could produce sufficient illumination to render the dark hemisphere visible in the daytime? Now if we write down six as the number of showers which appear in a century on this earth, and which are at all competent to render a planet visible at any time, we shall be considerably over the mark. We cannot, I think, expect that the number of swarms will, in the ordinary way, be more than twice as great per given unit of space, in the neighbourhood of Venus as near the earth. Putting the figure, however, far higher in our favour than we are really justified in doing, we find that perhaps twenty times in a century Venus may be sufficiently lit up by meteors to become visible. On quite two-thirds of these occasions Venus will be either so near the sun, or in so broad a gibbous phase, as to make the seeing of the dark side an impossibility. We are thus reduced to the possibility that perhaps six times in a century the dark side may be observable. But we are expecting a great deal more than we have a right to do if we suppose that out of these six times it will be observed more than three, whereas the actual number of times that the dark side has been seen is more like thirty, if not far greater.

We thus see that it is utterly impossible for meteor streams of the same order as those with which we are acquainted to produce an illumination anywhere near so frequently as is actually observed.

There is, however, an appearance sometimes seen in the evening sky, and going under the name of the Zodiacal Light. Now whether this appearance is due to a vast

flat disc of gas or to one of meteors, no one can deny that in its course round the sun, Venus passes through a very dense portion of its substance. If now we suppose this appearance to be composed of meteoric swarms, pursuing their way among each other in all directions, their orbits having a general coincidence with the plane of the ecliptic, a view which is gaining ground every day, we at once see how it is readily possible for meteor showers like our November displays to be comparatively common on Venus. On looking at the density of the Zodiacal Light at an angular distance of 40° from the sun, it seems to me as if it would be a wonder, the appearance being meteoric, if Venus were *not* illuminated at times in traversing these swarms. My own opinion is that if the night side of Venus never was illuminated, it would almost be prejudicial to the hypothesis of the meteoric nature of the Zodiacal Light, and in the same way the fact that this illumination can be explained on this hypothesis and on no other, appears to me a strong supplementary indication that this hypothesis is the correct one.

The above theory explains of course the intermittent nature of the light, and although meteoric swarms can only act on one side of a planet, yet in the nature of things, as a little consideration will show, it will only be when a swarm strikes a favourable half of the planet that the light will be seen. Also the movements of the planet are such as to cause the side thus illuminated to be the one most readily noticed by the observer when the planet is in the most favourable position for observation.

One question there is which cannot yet be decided, viz., Do these illuminations ever take place at the same point on the planet's orbit as previous illuminations? If it can be proved that they do, I think the matter might almost be regarded as permanently settled.

THE CHEMISTRY OF THE STARS.

IV.—STARS OF THE FIRST TYPE.

By A. FOWLER, F.R.A.S.

ALTHOUGH Secchi seems to have clearly recognised that the white stars of the "Orion" type were spectroscopically different from those resembling Sirius, he was satisfied to group together all the white stars under the general name of Type I. It has already been pointed out, however, that Secchi's classification is greatly improved by restricting the definition of Type I. so as to include only those stars in which the fine lines accompanying the stronger ones of hydrogen are chiefly of metallic origin, and giving the name of Type O to those stars in which the chief lines, apart from those of hydrogen, are principally due to helium and other gases.

Taking the first type stars in this restricted sense, Sirius may be regarded as the most typical example. Here the dark lines of hydrogen are overwhelming, but the additional lines seen in the best of modern photographs are very numerous and sharply defined, and by no means to be despised on account of feeble intensity. Their chemical significance has lately been very fully investigated by Sir Norman Lockyer, and the following short extract from his recent publication, to which reference has been previously made, will indicate the present state of our knowledge in this direction. It is necessary to explain that in this table the prefix "p" indicates that the line is an "enhanced" one, or one that is stronger in the spark than in the arc spectrum under ordinary conditions of experiment, "p" being an abbreviation for "proto"; the idea underlying the use of this term is that the enhanced lines appear under some condition of molecular simplification.

Lines in Spectrum of Sirius.		Chemical Origin.			
		Probable.		Possible.	
Wave Length.	Intensity. Max. = 10.	Origin.	λ.	Origin.	λ.
4000·0	1	—	—	p. Mn	4000·20
4002·7	2	p. Fe	4002·77		
4005·5	3—4	Fe	4005·41		
4012·5	2—3	p. Ti	4012·54	p. Cr	4012·63
4015·7	1—2	p. Ni	4015·76		
4024·6	1—2				
4028·5	1	p. Ti	4028·50		
4030·9	1	Mn	4030·88		
4033·2	1—2	Mn	4033·22	Ga	4033·13
4034·6	< 1	Mn	4034·64		
4035·8	2	—	—	Mn p. V	4035·80 4035·80
4046·0	3—4	Fe	4045·98		
4048·9	2	p. Fe	4049·00		
4052·3	1—2	p. Cr	4052·10		
4053·9	1—2	p. V p. Ti	4053·80 4053·98		
4057·6	1	p. Fe	4057·60		
4063·8	3	Fe	4063·76		
4067·2	3	p. Ni	4067·30		
4071·9	2—3	Fe	4071·91		
4075·6	1				
4077·9	3—4	p. Sr	4077·88		
4101·8	10	Hδ	4101·85		

From the complete table it appears that the following elements are responsible for the Sirian lines which have so far been identified:—

Aluminium.	Iron.	Silicium.
Barium.	Magnesium.	Strontium.
Calcium.	Manganese.	Titanium.
Chromium.	Nickel.	Vanadium.
Copper (?).	Scandium.	Yttrium (?).
Hydrogen.		

The significant outcome of the investigation is that the chemical origins of the majority of the Sirian lines have already been traced to terrestrial substances, and it is certainly too early to invoke non-terrestrial matter in order to explain the remainder. There is, in fact, no certain evidence of the presence of any substance in the Sirian stars that has not already been found in the sun and upon the earth.

This notable success in the interpretation of the Sirian lines, as will be seen from the wave-length table above given, is largely due to the comparatively recent investigations of enhanced lines; but while the chemical significance of such lines is beyond dispute, their physical meaning is not yet generally agreed upon. Sir Norman Lockyer, Dr. Scheiner, and others argue that they are the products of high temperature; Sir William Huggins seems inclined to account for them chiefly as an effect of reduced density, and others incline to attribute them, in laboratory experiments at least, to a particular electrical condition. Special attention has lately been given to the experimental study of the enhanced line of magnesium at λ 4481 (*see* KNOWLEDGE, February, 1903, p. 32, Fig. 4), which is very prominent in the Sirian stars. It has been shown that this line may be made to appear in the *arc* spectrum if the poles be surrounded by hydrogen or certain other gases, or when the arc is passed under water; while, on the other hand, it almost disappears from the spark spectrum when sufficient self-induction is introduced into the secondary circuit. Similar complex behaviour has also been recorded in the case of other

enhanced lines, but the view that they are generally associated with high temperature at least seems to have as much in its favour as any other which has been put forward.

It has long been recognised that the Sirian type of spectrum is closely related to the solar type, this connection being very clearly shown when intermediate types are studied. Such a connecting link is afforded by stars like Procyon, in which the giant hydrogen lines of the Sirian type are considerably toned down, while the metallic lines, notably those of calcium and iron, are correspondingly intensified. The perfect sequence from the Sirian, through the Procyonian to the Arcturian type, is clearly shown by the three spectra in Fig. 9.

Such photographic comparisons at once suggest that some variation in the condition of a Sirian star, without change of the materials involved, might modify the spectrum so that it became of the Procyonian type, while a further change in the same direction might well produce the Arcturian type of spectrum. The idea of a stellar evolution is, in fact, here presented in its greatest simplicity, and Sirius respectively, and on this supposition stars of the first and second types may be arranged as follows:—

		Increasing Temperature.	Decreasing Temperature.
Proto-Metallic Stars	Type I.	Cygnian	Sirian
	Type I.-II.	Polarian	Procyonian
Metallic Stars ...	Type II.	Aldebarian	Arcturian

On this view an Aldebarian star passes through the Polarian and Cygnian stages to a maximum of temperature represented by one of the groups of Orion stars, and then, with decreasing temperature, through stages represented in succession by the Sirian, Procyonian, and Arcturian types.

If the evolutionary idea be accepted, it follows that the chemical constituents of the Polarian, Cygnian, Sirian and Procyonian stars are identical with those of the Arcturian, and therefore with those of the sun. The

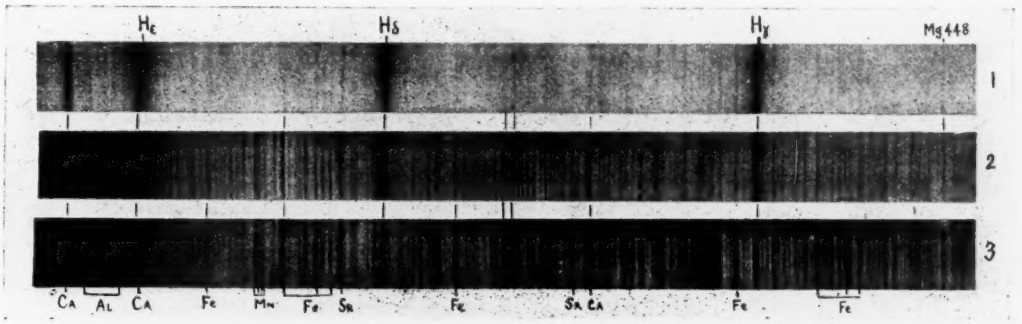


FIG. 9.—Photographic Spectra of β Arietis (1), Procyon (2), and Arcturus (3).

the substances actually represented in the three spectra being identical so far as they go.

There are good grounds for concluding that this change of spectrum from type to type is brought about by change of temperature. Apart from the indications afforded by the relative intensities of the proto-metallic and metallic lines, this conclusion is suggested by the difference in the strength of the violet and ultra-violet radiations in the three types of spectra. Experiments teach that as the temperature of an incandescent body, such as a platinum wire, is increased, the violet and ultra-violet rays are added in greater proportion than those less refrangible. Hence the greater intensity of the violet and ultra-violet radiations of Sirius as compared with Procyon, and of Procyon as compared with Arcturus, points to a reduction of temperature in the passage from the Sirian to the Arcturian type in the evolutionary process.

The consideration of the temperatures of stars, as indicated by the relative strengths of their violet and ultra-violet radiations, leads to another very important result, one which seems to indicate that the evolutionary processes are, perhaps, not quite so simple as might appear from the example already given. Sir Norman Lockyer finds that stars of about the same temperature may usually be divided into two groups, in one of which the hydrogen lines are much less strong than in the other, while the additional lines are of greater intensity. He concludes that the first series of stars are still increasing in temperature while the others are decreasing. Thus, Polaris and α Cygni nearly correspond in temperature with Procyon

argument for the distribution of solar and terrestrial matter throughout the universe, therefore, becomes stronger the more the spectra of the stars are investigated.

Some of the principal stars of Type I. and I.–II. are as follow:—

Type I.		Type I.-II.	
Cygnian.	Sirian.	Polarian.	Procyonian.
η Leonis	α Aquilæ	η Aquilæ	δ Aquilæ
α Cygni	β Arietis	ε Aurigæ	α Argûs
	β Aurigæ	δ Cephei	γ Boötis
	α Canis Maj.	γ Cygni	α Canis Min.
	δ Cassiopeiæ	β Draconis	β Cassiopeiæ
	α Cephei	ζ Geminorum	α Circini
	β Eridani	α Leporis	γ Herculis
	α Geminorum	α Persei	α Hydri
	β Leonis	α Ursæ Min.	γ Serpentis
	α Libræ		γ Tauri
	α Lyræ		ε Tauri
	α Ophiuchi		β Tri. Aust.
	α Piscium		θ Ursæ Maj.
	α Pisi. Aust.		
	β Ursæ Maj.		
	δ Ursæ Maj.		
	ε Ursæ Maj.		
	ζ Ursæ Maj.		
	γ Virginis		

JUPITER AND HIS MARKINGS.

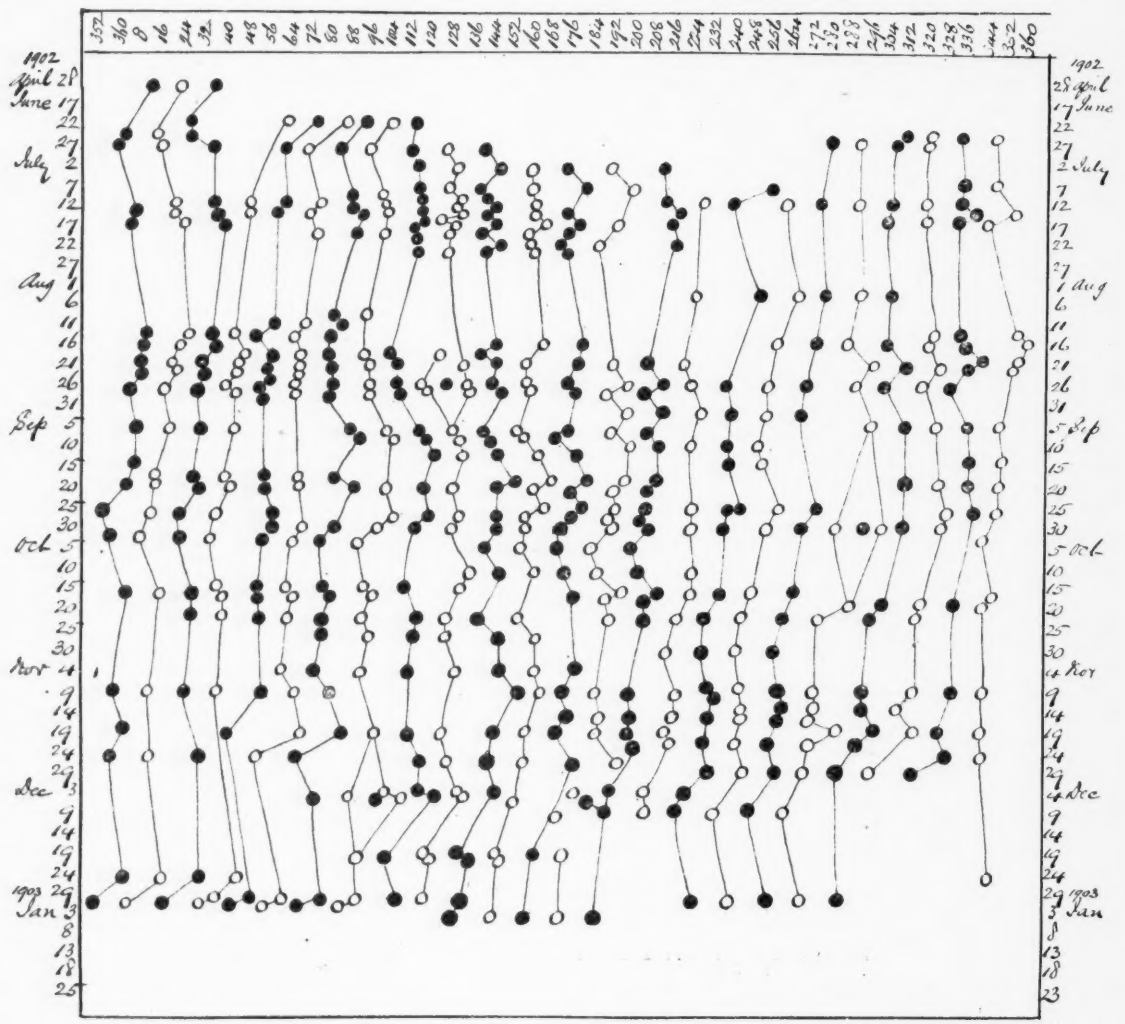
By W. F. DENNING, F.R.A.S.

THE surface phenomena of Jupiter show no present indication of declining in interest. Nor is it likely that the study

of this gigantic orb will ever be exhausted; the variations in his markings, both as regards their aspect and velocity, are so diversified and the objects so abundant that they offer a comparatively boundless field for investigation. There is indeed every reason to suppose that the ensuing few years will witness increased enthusiasm among Jovian students in the northern hemisphere, to whom the planet will attain a much greater altitude, and appear under a better defined aspect than during the past few oppositions.

As now displayed in the morning sky, Jupiter exhibits many prominent and curious markings. It is true that no in surveying this planet is to obtain as many accurate estimates as possible of the times when the various spots pass the central meridian, as these materials enable the individual rates of velocity to be ascertained. The belts and zones of Jupiter may be likened to a series of parallel rivers running along at different speeds, and the irregular spots floating in them afford just the clues required to enable us to ascertain the relative strength of the currents. The study of Jovian detail is essentially directed to questions of motion rather than of aspect, and in its aims and issues is very dissimilar to telescopic enquiries concerning Mars,

LONGITUDES OF THE EQUATORIAL SPOTS (White ○, Dark ●) ON JUPITER, 1902.



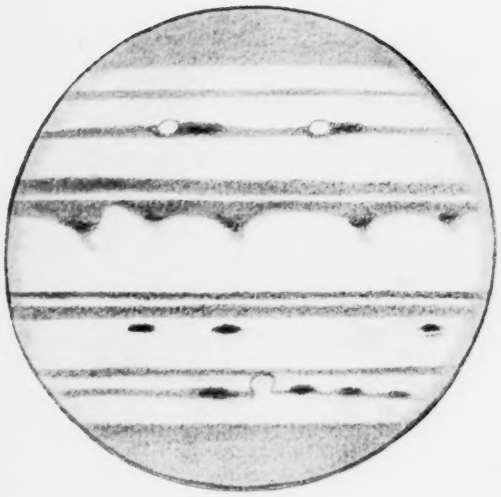
OBSERVATIONS WITH A 10-INCH REFLECTOR, POWER 312, BY W. F. DENNING, BRISTOL.

distinctly sensational feature happens to be visible, such as the slant-belt of 1860, the great red spot in its striking tint and bold outline of 1878-80, or the rapidly-moving north-temperate spots of 1880 and 1891. But there are a large number of objects perceptible which it is desirable to watch as closely as possible during the remaining part of the opposition. Observers who have micrometers would do well to determine the latitudes of the principal belts and spots every year. Perhaps, however, the main object which have special reference to the forms and positions of the lineaments. This is due to the fact that the spots on Mars are actual surface formations, one and all influenced by an invariable rotation period of 24h. 37m. 22·62s. But telescopic observers of Jupiter are merely studying the outside meteorology of the planet, since his vaporous envelopes preclude any closer acquaintance with the phenomena of his real globe.

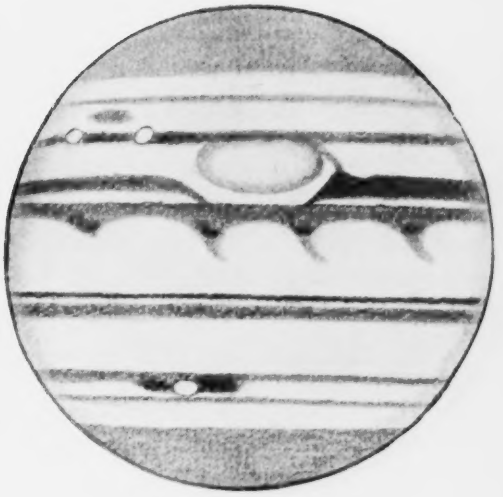
We may never be able to penetrate this obstructive veil

XUM

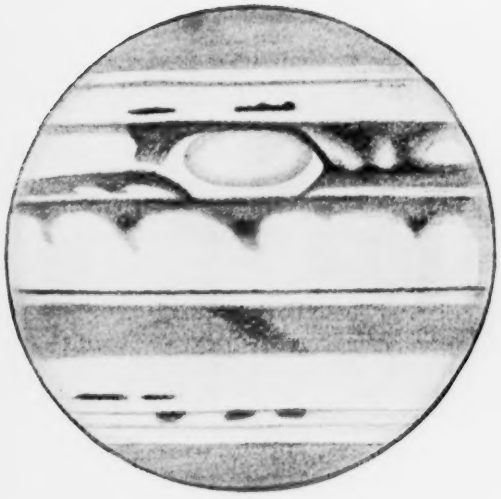
JUPITER AND HIS MARKINGS.



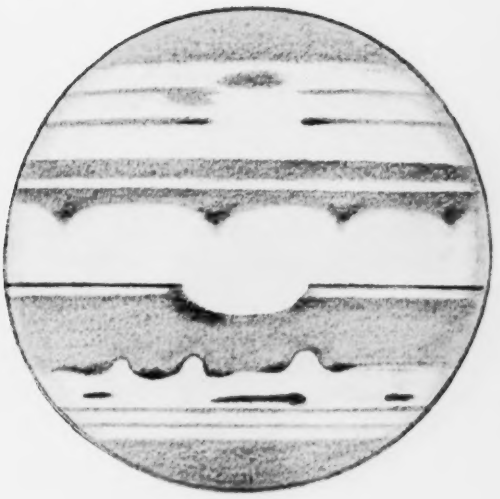
1903, June 20, 15h. 10m.



1903, June 24, 15h. 15m.



1902, July 7, 14h.



1902, July 13, 14h.

Taken with a 10-inch Reflector, power 312, by W. F. DENNING, F.R.A.S.

XUM

and gain a clear insight as to the topography of the disc; but what we discern amid the envelopes may afford an intimation of what is progressing below. There seems little doubt that frequent eruptions of material occur from the planet, and that the belts are often reinforced or intensified by this ejecta. A much heated condition of Jupiter seems a necessary inference, and there is observational proof that his giant sphere is in a state of considerable activity. By volcanic agency large volumes of material are probably discharged outwards, and these upon entering cooler regions may be partly solidified, and enabled to float on the heavier lower vapours. The red spot has endured so long, and retained such a permanency of shape, that it must be regarded as a very compact, stable object, possibly developed from some special outburst on the planet's surface at a rather remote period in the past.

More than once, remarkable outbreaks of dark spots have been observed, and these spreading out in a longitudinal direction have ultimately been drifted into new belts by the action of the very swift rotational velocity. But as all or nearly all the markings are influenced by proper motions, it is scarcely possible to ascertain the exact rotation period. There was an outburst of dark material from the planet in 1860 which seems to give us a good clue. It was spun into a new belt on the planet in a period of 64 days, but one end of the disturbance, probably representing the seat of energy, maintained a constant rate of 9h. 56m. 1s., while the other end showed an increasing velocity. If, therefore, we are justified in assuming that the dark material represented an uprush from the planet's surface, the value alluded to must closely approximate to, if it does not coincide with, the rotation period of the Jovian sphere.

In recent years spots may be said to have chiefly abounded in four latitudes, and to have given evidence of marked differences in rate :—

Latitude.	Mean Rotation Period. h. m. s.	Notes.
+25° to 30°	9 55 55·3	16 determinations.
+10° to 15°	9 55 31·2	35 determinations.
Equatorial Region ...	9 50 25·6	5 years, 1898-1902.
−25° to 30°	9 55 18·7	29 determinations.
Red spot and hollow in belt. Section of −20°	9 55 36·56	70 years' observations, 1831-1901. 61,813 rotations.

And these particular regions of the planet are at the present moment very rich in spots of various character. The sedulous study of these currents, and of the objects carried along in them, must be carefully pursued from year to year, for they may ultimately teach us something as to periodical changes of velocity possibly affecting them, as well as enable us to recognise recurrent markings.

In the spring of 1901 several dark projections were observed from the S. side of the S. equatorial belt. These intensified, and a considerable amount of dark matter was thereafter distributed over the S. tropical zone. This enveloped the red spot in July, 1902, and passed that object by flowing round its southern borders. The large tropical spot is still visible, though much fainter than formerly. On June 30 it extended over 47 degrees of longitude, and its centre was in transit at 15h. 34m. Comparing this observation with the position of the same marking at the middle of June, 1901, it will be found that it performed 1795 rotations in the interval, with a mean period of 9h. 55m. 18·6s.

But, of course, the most interesting object on Jupiter is the great red spot. This marking exhibited for many years a retardation in motion which increased its rotation period from 9h. 55m. 33·4s. in 1877, to 9h. 55m. 41·0s. in 1894. Since the latter year the mean values have been as follow :—

	H.	M.	S.		H.	M.	S.
1895 ...	9	55	41·1	1899 ...	9	55	41·7
1896 ...	9	55	41·3	1900 ...	9	55	41·7
1897 ...	9	55	41·5	1901 ...	9	55	40·6
1898 ...	9	55	41·6	1902 ...	9	55	39·0

The spot now follows the zero meridian of Mr. Crommelin's System II. by 52 minutes = 31°·4 of longitude. The observations obtained at Bristol since Jupiter became a morning star are as under :—

1903.	Transit Time. H.	M.	Longitude. °
May 26 ...	16	18 ...	29·5
„ 31 ...	15	28 ...	30·4
June 5 ...	*14	33 ...	28·3
„ 24 ...	15	20 ...	31·6
„ 29 ...	14	29 ...	32·3
July 1 ...	16	7 ...	32·1
„ 13 ...	16	2 ...	32·8

The earlier observations seem to place the spot too far W., but at the time they were made the planet was small and altitude low, and results obtained under such circumstances are rarely so good as those secured nearer the date of opposition. Quite possibly the motion is again retarded.

The chart of equatorial spots visible in 1902 shows their various longitudes during the last six months of the year. The mean rotation period of 24 white and dark spots was 9h. 50m. 26·7s. The irregularities observable in the projected longitudes suggest that these markings have a curious oscillatory motion, and such is indeed the case, though certainly not to the extent apparent in the drawing. Errors in the observed transit times must be partly responsible for a number of the displacements, and considerable changes occur in the dimensions and visible aspect of the spots which must naturally influence the results. But apart from these disturbing causes, the markings have undoubtedly a to-and-fro movement in longitude which sufficiently proves that the equatorial current is subject to decided sectional fluctuations.

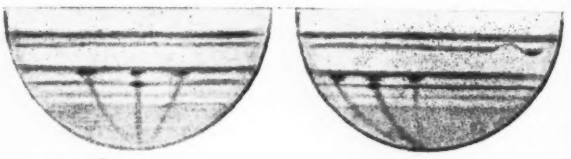
A discussion has recently taken place in *Popular Astronomy* as to the relative value of transits of spots obtained by micrometric measurement and by simple eye estimation. There is really a very trifling difference in the accuracy of the two methods. The micrometer seems capable of furnishing results a little more exact than those depending solely on the eye, but the difference is so small that it may be practically disregarded. Eye-estimated transits are often very precise, for the rapid rotation of Jupiter palpably displaces objects near the central meridian in two or three minutes. Two, or even three minutes of error in the transit time of a spot possess little significance, since the rotation periods are often derived for intervals embracing more than three hundred rotations, and the error will only amount to the small fraction of a second. Even the spots themselves vary in their periods to the extent of ten or twenty seconds or more! What is of far greater importance in studying the markings is to make a large number of observations so as to be *practically certain of their individual identifications*, and to follow them over as long a period as possible, so that the observational errors may be minified, if not eliminated, by their division among a large number of rotations. The misidentification of markings, and the shortness of the period over which they have been observed, have furnished fruitful sources of error.

As to the surface currents, whatever may be said in opposition to the plan of sorting them into zones or parallels of latitude, and ascribing mean rates of motion

* Estimate doubtful, the spot being some distance west of the meridian.

for each one, the plan is necessary, and naturally suggests itself as likely to facilitate the easy retention of our knowledge of detail. The method is certainly not perfect in its application to all the facts accumulated. For instance, spots have temporarily appeared in the north-temperate region with a rotation of only 9h. 48m., yet the normal rate of this latitude is 9h. 55m. 55s., and represents the slowest current of all. But the rapidly-moving spots alluded to formed a very exceptional incident, and should not be allowed to negative a system which has much to recommend it.

Occasionally there are seen markings on Jupiter of a very curious and special description, and apparently dissimilar to all the rest. These are in the form of faint dusky streaks, running from spots on the north-temperate belts to the region of the north pole. They cross the belts at right angles, and one of these features—the centre of three—was very conspicuous on July 1, 1903, in longitude 13°, and in transit at approximately the same time as the preceding end of the great red spot. The aspect of these northern latitudinal spots was somewhat as under:—



15h. 36m. 16h. 12m.

Northern Hemisphere of Jupiter, July 1.
10-in. Reflector, power 312.

They are not often visible, and I am not aware who was the first discoverer of markings of this kind, but they are certainly of a distinctive and interesting character, and deserve more attention than they have hitherto received. I must confess, however, that I cannot altogether do away with the impression that they are an optical illusion. The spots to which these polar streams are attached are located in a latitude which is rather productive of discordant phenomena, and often displays a considerable amount of activity. It is in this north-temperate region of Jupiter that the swiftest and the slowest spot-motions have been determined, and these and other anomalies present a strange contrast to the behaviour of the south-temperate belt, which has preserved a very equable rate of about 9h. 55m. 18·7s. during many years.

Accompanying this paper are four representations of Jupiter—copied from drawings made at the telescope—and they will sufficiently illustrate the general aspect of the planet in July, 1902, and June, 1903, without presuming to critical exactness as to the positions in latitude.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

"MOLECULES AND HEAT."

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I would like to say a few words upon Mr. Edser's most fair criticism* upon my work on "Molecules and Heat." Writing upon the theory my experiments have suggested—I think proved—he states, "Such a theory labours under all the difficulties that beset the old caloric theory." There is a great difference between this new theory and the old caloric theory. My view is that the molecule is *not a constant in dimensions*. The old caloric and the kinetic theories regard the molecule as constant in dimensions. The fundamental fact—the all-important fact to be explained is: eliminating the change of state in the molecule—crystallization—any theory must explain why matter, especially liquid and gaseous matter, becomes lighter as it increases in temperature—for instance, hot water floats upon cold water. Now, my view explains this, but no other theory does.

Physical science is full of what appear to me to be contradictions in terms, which are believed in by men who carry my highest esteem. Speaking of the objects—spheres—I have shown floating in air, Mr. Edser says, "The accepted explanation of this depends on the fact that a gas or liquid exerts considerable friction on very small particles, which are thus unable to sink quickly." This I understand to mean, that there is contact between the gas or liquid molecules and these small particles to produce friction. Then he goes on to say, "The flask is filled with aqueous vapour, the invisible small molecules of which are comparatively widely separated from each other." A little thought will show that these two statements are a contradiction in terms. Now the views I have shown (which are derived wholly from experiment) give the friction Mr. Edser properly wants to import, and no other view does this. Then he repeats the wide-spread error, that the particles of dust in the air are centres of condensation, producing "small water droplets." Quite forgetting that experiment shows that such droplets gravitate, whereas the objects I have shown him *rise from the liquid*—in fact, dart off the liquid. To complete Mr. Edser's idea, we should see raindrops jumping up from the pavements and ascending to the skies, but who has ever seen such a phenomenon? Besides, I have shown experimentally that the particles of dust in the air are not the factors in condensation, for we obtain condensation without these motes, and with a single element, say, oxygen gas. Then Mr. Edser objects to the concept that "a water molecule as a spherical body composed of a *great number* of atoms of oxygen and hydrogen, in the proportion of one of the former to two of the latter," but goes on to say that this molecule consists of "one atom of oxygen and two atoms of hydrogen." Where is his authority for such a statement? He will reply that he obtains it from the chemist. But where is the chemist's authority? Absolutely he has no data, because if what I have shown is not the molecule, then no human eye has ever seen the molecule, and it is my audacity in stating that nature will show this object if we approach her with a neutral mind, which makes Mr. Edser say that "nothing could well be more startling than such a claim." The fact is, the deductions I have arrived at are built up from many more experiments than time permitted me to show Mr. Edser, especially experiments interpreted by the thermopile and the thermometer.

FREDERICK HOVENDEN.

West Dulwich, July 9th, 1903.

* KNOWLEDGE, 1903, page 160.

RARE CONDITION OF THE HUMAN HAIR.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Dr. Walter Kidd's note under this heading is interesting, but I hardly think he is warranted in concluding that the abnormal condition he describes may have been inherited.

It would be first necessary to ascertain that the part where the truncated hairs appear had not been subjected

to continued friction. In some observations of my own I found a similar condition of the hair on the outer part of the skin, and traced its cause to the person sleeping with legs crossed. In this case there was the additional peculiarity that, whereas some of the hairs had been regularly worn down to the skin surface, others had never succeeded in emerging from the skin, but had grown to a length of half an inch or more *beneath* the outer skin, through which they might be seen just below the surface. They could readily be lifted out with a needle point. Can Dr. Kidd suggest a cause for this mode of growth? Friction alone would hardly account for it, but perhaps pressure plus friction may have forced the hair point to take a right-angled course.

W. S. Rogers.

[The particular case referred to by Mr. Rogers, in which the hairs of the leg were found lying buried under the epidermis instead of projecting at an acute angle, is interesting, but I cannot see why any other force than that of the peculiar pressure exerted is required to account for the condition. I think friction would tend to prevent rather than favour the position of the hairs.

My own case is, of course, defective, as there is no evidence, except the man's own testimony, that it existed in early life. It is hardly possible that special friction or pressure could have been affecting for many years the two borders of each hand, and the middle of the dorsum of each be missed out, and the dorsal surfaces of the phalanges also affected. Besides which there were a few stray normal hairs of full length interspersed with the truncated hairs. But the situations where these truncated hairs were found are just those where the accumulated effects of repeated friction through many generations would be found, if at all.

It might be held that some unknown microbic or pathological origin could be assigned for the state of the hairs, but this is hardly possible, seeing how long the condition had lasted and that the skin was healthy and clean, and that normal were interspersed with abnormal hairs.

Walter Kidd.]

6th July, 1903.

THE CROSS OF S. SOPHIA.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I was abroad during April and did not see Mr. Antoniadi's rejoinder about the Cross of S. Sophia until I returned home. Mr. Antoniadi can hardly expect universal credence for his interpretation of the lines of the Silentiary's poem, which were so broken that neither Gräfe nor Bekker ventured to restore them. Moreover, the fragments quoted by Mr. Antoniadi (Knowledge, p. 91) do *not* state that the crown of the dome was adorned with a picture of Christ in Glory; they only say something about "mosaic" and "saving" and "guarding" and "the Saviour of the World." Such words are quite as likely to flow from the pen in describing a mosaic Cross as a mosaic Christ.

The "Painter's Manual" doubtless gives us the later praxis, but I never imagined that it was supposed to reflect the usage of pre-Iconoclastic days. No one doubts that a mosaic of Christ in Glory filled the centre of the dome in 1453 (Du Cange, p. 548; Lethaby and Swainson, pp. 278, 286), but there is nothing to suggest that this mosaic, or any other of the figure mosaics, is older than the Emperor Basil the Macedonian (867 A.D.). Messrs. Lethaby and Swainson may speak for themselves: "The figure scheme, so far as it can be traced, closely agrees with the Byzantine Manual of Painting; and the subjects and treatments can be associated with work in other churches of the ninth and tenth centuries which have in several cases almost identical designs. Altogether, it may be doubted if a single figure belongs to a time anterior to the Iconoclastic period of the eighth century. We believe the original scheme of decoration is best accounted for without figures, and even if this were not so, we can hardly believe that in the Patriarchal Church at the door of the Palace figures would have lasted through the reigns of the Iconoclastic emperors and patriarchs" (p. 280). "It is quite certain from Procopius and the poem of the Silentiary that the vaults of Justinian's church were covered with mosaic. They both describe the brilliance of the gold glittering surface, but do not mention any figures. In such detailed descriptions this silence goes far to show that there was originally no storied scheme of imagery, like that which the Poet so fully traced out on the curtains and iconostasis" (p. 282). Messrs. Lethaby and Swainson then go on to compare the Cross which they understand the Silentiary to describe at the highest point of the dome with the decoration of the well-known tomb of Galla Placidia at Ravenna, where the dome is covered with blue mosaic sprinkled with golden stars, and at the top is a golden Cross.

As to the translation of the lines about the ἐρυσίπτολιν σταυρόν, upon which the whole dispute hangs, I would ask those readers of Knowledge who have not already made up their minds, to consider the general plan of the Silentiary's poem, a plan which I venture to think inconsistent with a reference to an outside cross. Excluding the 304 lines on the Ambo, the poem on S. Sophia is 1029 lines long. Of these, the first 350 lines are introductory, and speak of the fall of the previous church and of the solemn inauguration of the present building on Christmas Day, 563 A.D. The last 109 lines are a panegyric on Justinian. The rest of the work, over 550 hexameters in length, is taken up with a detailed description of the *inside* of S. Sophia. The poet describes in turn the Eastern Apses, the Chancel Arch, the West End, the Narthex, the Four Piers that support the Dome, the Pendentives, the Cornice of the Dome, the Dome itself, the North and South Walls, the North and South Aisles, the Gynaecea, the Atrium, the Marbles, the Inlaid Work, the Capitals, the Floor, the Gold Mosaic, the Iconostasis, the Ciborium, the Altar, the Altar Curtains and the Pictures embroidered on them, and, finally, the arrangements for Lighting. But not a word is given to the outside. The description of the Lamps ends up with a declaration that the mariner, coming at night to Constantinople from the Ægean Sea, guides his ship not by the stars but by the lights of S. Sophia, shining through the windows in the lower part of the Dome.* Yet even here we are dealing with lights inside the church, not with an object placed on the outside. It is therefore wholly improbable that Paulus, while describing the inside of the Dome and comparing it to the vault of heaven, should suddenly pass through the tiles and tell us in ambiguous language of a cross on the outside of the Dome. Every other object mentioned by Paulus is visible from the inside.

Mr. Antoniadi has failed to bring forward any passage in which the verb γράφειν is used of sculpture or raised metal-work. The word is used of *writing* or *drawing*, in fact of any surface decoration. Thus in the Silentiary's Poem, ii., 232, ἔγραψε is used of designs made in marble inlay on the walls. But even granting that the primary meaning of γράφειν is "to scratch, to incise," few people would suppose that when Paulus says "a cross was scratched over the top of the dome" he really means "a

* Compare Mr. Antoniadi's charming drawing (Knowledge, p. 27).

cross was artfully carved out of metal and set up on the outside." Paulus evidently did not like to think of the Cross as plastered up against (ἐπί) the crown of the vault, though of course this was physically the case. His phrase seems to imply that he thought of it "as though it were suspended from heaven," to use the words of Procopius. Hence the employment of ὑπέρ—the Cross seemed not to be fastened upon the ceiling of the dome, but to be hanging over it.

In conclusion, I disclaim altogether any "desire to deprive mediæval Greek Churches of their outer cross," but I denied, and still deny, that the Silentiary mentions such a cross. And I am surprised that a writer who understands ἔγραφε to mean "artfully carved out of metal" should accuse my interpretation of artificiality.

F. C. BURKITT.

Elterholm, Cambridge.

P.S.—Since writing the above I have read Mr. Antoniadi's remarks on p. 102. The line from the Silentiary to which he refers (ii., 294) is ἄλλοθι δὲ χριστοῖο κατέγραφε μητέρα τέχνη. This refers not to a *statue* but to a *picture* of some kind, whether in incised metal or enamel or mosaic, or it may have been a wooden panel covered with metal plates. What I have denied, and still deny, is that γράφειν (or καταγράφειν) can be used for a detached object such as a standing cross or a statue. Or to put it into English, I deny that "to engrave" can ever mean "to set up."

The whole later scheme of decoration is fully treated by Lethaby and Swainson, as the extracts I have quoted sufficiently show, and I would refer readers of KNOWLEDGE once more to their book.—F. C. BURKITT.

[The reply to the various points raised by Mr. Burkitt is easy and obvious. In the first place he says that my quotation from the Silentiary (p. 91) does "*not* state that the crown of the dome was adorned with a picture of Christ." But in this he is mistaken, as the poet speaks, in his description of the dome, of "a circle," of "mosaic," and of "the Saviour of the World"; and as the cupola of St. Sophia has only one circle, the one formed by the ribs at the crown, any allusion to "a circle" and "mosaic" in the dome must necessarily refer to the crown. Then Mr. Burkitt asks us to believe that these words "in a circle," "mosaic," and "Saviour of the World," may have applied to a cross. This is a gratuitous supposition, and, considering that there is no mention whatever of a cross here, its conception has no counterpart in the world of fact, and cannot deserve serious attention.

Again, the quotation that "there was originally no storied scheme of imagery" in St. Sophia is opposed to evidence, as in the church of San Vitale, in Ravenna, built by Justinian, we find mosaic images of Christ, the Lamb, of angels, of Justinian and Theodora, and of a crowd of saints and apostles in great profusion. And if a provincial church was so richly endowed with eikons, is it not illogical to assume that the synchronous great central cathedral had no mosaic images whatsoever?

The evidence of the mausoleum of Galla Placidia has no bearing on the discussion, as there cannot be any comparison between the arrangements of a mere tomb and those of a great cathedral. Also, the attempt to preclude the Silentiary from describing any outer object of the church is contradicted by facts, since the poet describes in detail the open atrium, which, at variance with Mr. Burkitt's belief, formed an integral part of St. Sophia on the outside.

Mr. Burkitt says further that I have "failed to bring forward any passage in which the verb γράφειν is used of sculpture," when on p. 102 of the May number of KNOWLEDGE I have shown the poet to connect the form ἔγραψε with its subject λιστόρος, stone-borer, or sculptor!

On p. 30 I remarked that the expression "*above* the highest summit" could evidently never apply to an inner cross—a difficulty which Mr. Burkitt never overcame. The late Mr. Swainson got rid of the obnoxious adverb, or preposition, by altering its meaning into *at*, but Mr. Burkitt has tried to reconcile it with an inner cross, the result being that he located his cross in the very thickness of the bricks (p. 84). This check did not discourage him, however, since he now ventures to conceive the accurate Silentiary to have meant that the cross floated above the position where it was depicted, although it is fair to add that Mr. Burkitt at once acknowledges the physical impossibility of his own assumption.

I am glad to see Mr. Burkitt admitting at last that γράφειν originally meant "to scratch, to incise"; and yet it is noteworthy that he triumphantly makes me mean that "a cross was *scratched* at the top," prudently avoiding to say that it was "*incised*," as the latter verb settles immediately this baseless discussion.

With regard to the last sentence of his letter, I support my interpretation of the words τέχνη ἔγραφε Σταυρὸν ὑπὲρ ἀκροτάτης κορυφῆς, "art *incised* or *carved* a cross above the most culminating summit," since the English verb *to carve* is etymologically akin to the Greek γράφειν, and because γράφειν was, according to the Silentiary, a function of the sculptor (p. 102).

On p. 84, Mr. Burkitt said that I brought "no evidence in support" of my "contention" that St. Sophia had a cross on the dome, like St. Paul's, asking me to convince him that there was such a cross. Now, considering that the need of conviction implies disbelief, Mr. Burkitt evidently deprived St. Sophia, and all Greek churches, of their outer cross. This was straining facts too much. Realising the gravity of such a situation, he now boldly refutes his primæval argument by disclaiming "altogether any 'desire to deprive mediæval Greek churches of their outer cross.'"

In short, my claim that the inner crown of the dome had a Justinian image of Christ becomes a fact, since it is confirmed by ocular witnesses at the time (p. 102), and this carries, of course, the cross outside; whereas Mr. Burkitt's mosaic cross, unseen by anybody, and resting on no facts, could naturally never step outside the bounds of subjectivity, throughout the present discussion.—E. M. ANTONIADI.]

[In reply to his P.S., I thank Mr. Burkitt for having granted that γράφειν meant *to incise*; and as that verb, in English, means not only *to cut superficially*, but also *to cut right off*, we reach a demonstration of the fact that ἔγραφε was perfectly applicable to the solid cross of the dome.

The kindred verb χαράσσειν, to *incise*, is also used (p. 102) by the poet to say that a wall was *cut off* at a definite height.—E. M. ANTONIADI.]

"COMETS AND THEIR TAILS AND THE GEGENSCHEIN."

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I must protest against the assumption made in a review of the above work, in your issue for June, that my work constitutes a revival of Tycho Brahé's theory.

The refractive and consequent concentrative influences of the atmosphere of comets has not (previously to my work) been recorded. Even if any thinker had advanced similar views to mine, does this render the arguments I use any the less weighty or deserving of attention?

The writer of this review mentions a comet of 1823 and 1351. I can recall no comet of the former year, and

presume he is alluding to the comet of 1824. Unfortunately but little data is to hand as to these comets. Photography was not known. Were they to appear now, sufficient data could undoubtedly be collected either to confirm or disprove my theory. The only comet from which rays were apparently lying on the line of the "radius vector" was that of 1882, faint indications of which are discernible in the photographic views of this comet on November 7th, 1882. These photos were taken at the Cape, and a faint ray running into the head of the comet is distinguishable for a short distance from the head and *decreasing* in width as the rays leave the comet. In my own mind there is only one explanation for this luminous appearance, and it is that there must have been a comet travelling probably in the same ellipse and as an attendant body whose head was lost in the brightness of the sun but whose tail ran into the big comet on that date and was thus caught in these photos. This may or may not have been the case with the comets the reviewer wishes to quote. We have not, however, sufficient data to determine this point.

In conclusion, I must protest against the remarks that the reviewer has noticed several errors in my work. He only quotes two of the said mistakes, one obviously a printer's error, in which the year 1774 is printed instead of the year 1744. The other is no error, namely that *Donati's* comet was first discovered by Tuttle. I omitted to say "in America," and the meaning I had must be perfectly apparent by the text following the sentence, and also from my using the European discoverer's name. No other printer's errors exist and no other omission of words can be laid to my door in the whole of my work.

Fred. G. Shaw.

[Mr. Shaw's letter can hardly be said to strengthen his case. He says that he can recall no comet of the year 1823, but any astronomical work will inform him that a bright comet passed its perihelion on December 9th of that year. It was visible during the months of December, January and February, 1823-4. Hind referred to this comet as "remarkable for having exhibited a tail directed towards the sun in addition to another in the usual position." The fourth comet of 1851 presented a similar aspect, its tail "consisting of two branches, one of which was turned towards the sun." There are other instances, in spite of Mr. Shaw's assertion that the comet of 1882 supplied the only case of the kind. Your correspondent remarks that his statement "Tuttle discovered Donati's comet on June 2nd, 1858," was no error, only an omission of the words "in America." He evidently does not believe in errors of omission as well as errors of commission! Mr. Shaw's revival of old theories regarding comets' tails is never likely to exercise any weighty influence in explaining the phenomena recorded. The behaviour and occasional positions of the tails of comets would certainly suggest that they are NOT due to the action of refractive atmospheres surrounding the nuclei. A theory to commend itself must agreeably accord with observed facts, and will neither present serious discordances with them nor require us to adopt very improbable assumptions.—The Reviewer.]

Notes.

Astronomical.—The important part in cosmical phenomena which is probably played by the pressure due to radiation is receiving considerable attention at the present time. In 1873 Clerk Maxwell showed that if light be an electro-magnetic phenomenon, the absorption or reflection of a beam of light should produce a pressure, and he further computed the amount of this pressure. A year or two ago Prof. Lebeden, of Moscow, convinced himself of the existence of such a pressure, and found from his experiments that, within the limits of error, its amount was equal to that theoretically arrived at by Maxwell. A more complete investigation has recently been made by Professors Nichols and Hull, of Dartmouth College, U.S.A., and Maxwell's conclusion is again confirmed. It appears also that the radiation pressure depends only upon the intensity of the radiation, and is independent of wave-length, so that the long invisible waves are as effective in producing pressure as are the visible radiations. In attempting to apply this result to cosmical phenomena, it is to be borne in mind that while the gravitational attraction on particles varies with the centre of the radius, the repulsion due to radiation varies with the square of the radius, so that the ratio of repulsion to attraction will increase as the particles diminish in size; but a limit is reached when the particles are so minute that the radiation pressure is dispersed through diffraction phenomena. For this reason gases and vapours are not subjected to pressure from radiation, and the maximum ratio of radiation pressure to gravitation is about 20 to 1. The forms of comets' tails may be thus satisfactorily accounted for, the form depending on the size or density of the particles repelled from the head. Professors Nichols and Hull also describe an experiment for illustrating the formation of a comet's tail, and deal very fully with the whole subject in the June number of the *Astrophysical Journal*.—A. F.

Botanical.—The last number of the *Transactions of the Linnean Society* consists of an admirable contribution to our knowledge of insular floras in Mr. T. F. Cheeseman's "Flora of Rarotonga." Rarotonga is the chief island of the Cook group, situated in the Eastern Pacific, between the Tonga and Society Islands. Though discovered in 1821, and occupied by Europeans nearly the whole time since, scarcely anything has hitherto been published on its flora. The present paper includes an enumeration of the plants collected by the author during a three months' visit, made at the most suitable time of the year for studying the vegetation of the island. It is, therefore, practically a complete flora of the Phanerogams and Ferns. Rarotonga is of volcanic origin, and is about eight miles long and six broad. Near the sea there is a level tract of land, varying from a quarter of a mile to a mile in width, extending all round the island, while the centre is a mass of rugged mountains, ranging from 1575 to 2250 feet high. Forests abound, but the herbaceous vegetation, except numerous ferns, is scanty. With the inclusion of nearly one hundred species, which have with more or less certainty been introduced, the flora as at present known consists of three hundred and thirty-four vascular plants, of which no less than sixty-seven are ferns. Eighteen species belonging to sixteen natural orders are probably endemic. Perhaps the most remarkable plant amongst these is *Fitchia speciosa*, a new species of a curious genus of Compositæ, hitherto known only from the Society Islands, where three species are found. *F. speciosa* is common on all the mountains of Rarotonga. It is a small handsome tree, with fine glossy leaves and large orange-red flower-heads. The flora of Rarotonga resembles most closely that of the Society Islands, having one hundred and sixty-seven species in common, while one hundred and three of the same species are also found in the Tonga group.—S. A. S.

Zoological.—In a paper recently read before the Linnean Society, Mr. B. A. Bensley discusses the origin

and classification of marsupials. Too much emphasis, he believes, has been laid on the character of the dentition, and foot-structure is regarded as a surer guide for systematic arrangement. The ancestral forms were probably insectivorous; and from these evolution proceeded on two lines, one culminating in the herbivorous kangaroos, and the other in the carnivorous Tasmanian devil.

No. 475 of the *Proceedings* of the Royal Society contains an important communication by Dr. L. Rogers on the action of the poison of the sea-snakes. This venom is found to be much more virulent than cobra-poison, especially in its effects on fishes, which form the food of these reptiles. It acts by paralysing the nerve-centres, and, unlike cobra-poison, has little or no effect on the coagulating property of the blood. In the symptoms produced it is, however, very similar to cobra-poison, whence it is inferred that the latter also causes death by acting on the nervous system.

The same journal also contains a preliminary account of Miss Bates' discovery in the superficial deposits of Cyprus of remains of pigmy elephants closely allied to those so long known from Malta. The Cypriot form is regarded as a distinct species, but it may be a question whether it is more than a variety. When fossil elephants were discovered in Malta, it was a practical certainty that they would turn up in the other Mediterranean islands, if only there were deposits suitable for the preservation of their remains.

The various American races of reindeer, or caribou, are admirably described and contrasted in an article contributed to the Seventh Annual Report of the New York Zoological Society by Mr. M. Grant, the Secretary. The author is of opinion that all, or nearly all, of the existing Old World reindeer are allied to the American Barren Ground caribou; but since antlers resembling those of the woodland race are met with in the superficial deposits of S. Europe and Asia, it is considered probable that the latter animal reached America from Asia by way of Bering Strait.

The May issue of the *Quarterly Journal* of the Geological Society contains the full account of the remains of mastodons and sabre-toothed tigers recently discovered in a Derbyshire cave of Pliocene age. It appears that this important discovery was made accidentally by a schoolboy, who picked up some mastodon teeth among the *débris* from a quarry; unfortunately many other teeth were buried deep in the talus. This discovery should convince those who argue that the Crag mastodons were not natives of Britain of their error.

A bulky memoir on the mummified animals of ancient Egypt appears in the eighth volume of the *Archives* of the Museum at Lyons, by Messrs. Lortet and Gaillard. An extraordinary large number of species—both wild and domesticated—have been identified from their mummified bodies; among the latter being the bubal, or lesser hartebeest (*Bubalis boselaphus*), and the arui, or North African wild sheep (*Ovis lervia*).

THE EARTHQUAKE OF JUNE 19TH.—Three months ago we recorded the occurrence on March 24th of an earthquake in the west of Derbyshire, strong enough to cause some slight damage to buildings and to disturb an area of about 13,500 square miles. This was followed on June 19th, at about 10.8 a.m., by a shock which, if it resulted in no loss to property, affected a still wider area. It was felt along the east coast of Ireland and for some distance inland, from Wexford to several miles north of Dublin. In the southern half of the Isle of Man it was distinctly perceptible, and was at once recognised as an earthquake shock. On the other side of the Channel the disturbed area includes the whole of North Wales, and probably the greater part of the principality, although no records are as yet forthcoming from the counties of Pembroke and Glamorgan. In England the shock was noticed as far east as Warrington and at several other places in Lancashire. Thus, even if we exclude isolated records from places so far distant as Belfast and Kendal, the disturbed area can hardly have been less than 220 miles long from north-east to south-west and 170 miles wide, and must have contained about 30,000 square miles. The district most strongly shaken was a band embracing the west coast of Carnarvonshire from Nevin to between Carnarvon and Bangor, and the centre was probably not far from Clynnog, though whether under land or sea it is at present difficult to say. The principal shock appears to have been simple in character and of unusual duration. At Birmingham it was registered very clearly by a horizontal pendulum designed by the distinguished Japanese seismologist Prof. Omori. The last earthquake of any consequence originating in this district was one that occurred on November 9th, 1852, and disturbed an area of about 70,000 square miles, including parts of all four kingdoms.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Black-winged Pratincole (Glareola melanoptera) in Kent.—At the June meeting of the British Ornithologists' Club, Dr. N. F. Ticehurst exhibited a male specimen of this Pratincole. The bird was shot by Mr. F. Mills, in Romney Marsh, in May last. This species of Pratincole has not been recorded before from the British Islands. It differs from the Collared Pratincole in having black instead of chestnut under-wing coverts and axillaries.

Collared Pratincole (Glareola pratincola) in Kent.—At the same meeting, Dr. Ticehurst exhibited a male specimen of this Pratincole, which had been shot very near the same place as the above, on May 30th, by Mr. Southerden. This bird breeds commonly in southern Europe and North Africa, and occurs now and again in Great Britain, but it has not been recorded before for Kent.

Blue-headed Wagtail (Motacilla flava) breeding in Sussex.—In 1901, Mr. Ruskin Butterfield recorded that a pair of these birds had nested in Sussex (*see* KNOWLEDGE, 1901, p. 281). At the June meeting of the British Ornithologists' Club, Dr. Ticehurst exhibited a nest and eggs of this species, taken on May 21st last, within twenty yards of the spot where the 1901 nest was taken. With these two records, and the evidence of a regular migration of these birds on the coasts of Kent and Sussex (*see* KNOWLEDGE, January, 1903, p. 12), the Blue-headed Wagtail has become more than a chance visitor to our shores.

White Wagtail in the West of Ireland.—The White Wagtail has been observed to visit Co. Mayo in the month of May for six years in succession, and a further proof of the migration of this species up the west coast of Ireland is afforded by Mr. R. M. Barrington, who now records the presence of these birds on the coast of Donegal last May.

Early Arrival of Swallows in Ireland. (*Irish Naturalist*, 1903, July, p. 198.)—Mr. R. J. Ussher remarks that Swallows are seldom observed in Ireland before April, but that this year they appeared over a wide area in March.

Woodchat Shrike in Yorkshire. (*The Naturalist*, 1903, July, p. 262.)—Mr. C. G. Danford records that he saw a Woodchat Shrike on May 9th at Speeton. The Woodchat rarely visits England.

Hawfinch in North Dumfriesshire. (*Annals Scot. Nat. Hist.*, 1903, July, p. 184.)—An adult male Hawfinch was picked up dead near Kinnelhead on April 6th last. The bird is rare in Scotland.

Grey-headed Wagtail (Motacilla viridis, Gmel*) in Yorkshire and in Sussex.*—At the May meeting of the British Ornithologists' Club, three adult male specimens of this Wagtail were exhibited. One was caught in a lark net at Halifax, Yorkshire, in the spring of 1901, and was exhibited by Mr. W. E. de Winton on behalf of Mr. W. Eagle Clarke. The two other specimens were shot near Willingdon,

Sussex, on May 13th last, and were exhibited by Mr. Ruskin Butterfield. This Wagtail, which is also known under the name of *M. borealis*, Sundev., is much like *M. flava*, but has the head blackish-grey instead of ashy-blue. The Grey-headed Wagtail breeds in northern Europe and Siberia, and migrates to South Africa and India. Two specimens are said to have occurred at Penzance, but the above are the first authenticated records of its occurrence in the British Islands. Judging by its distribution, one would have expected this Wagtail to have occurred more often on our eastern seaboard.

Black-headed Wagtail (Motacilla feldeggi, Michah*) in Sussex.*—At the same time and place as the two Sussex specimens of *M. viridis* were obtained, an adult male of *M. feldeggi*, Michah, or *M. melanocephala*, Licht., was shot. This Wagtail has a black head, and is altogether a darker and more richly coloured bird than *M. viridis*. It also winters in Africa and India, but its summer haunts are in south-eastern Europe, Persia, and Central Asia, so that it can never be regarded as anything more than a straggler to these islands.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

Notices of Books.

"THE SOIL: AN INTRODUCTION TO THE SCIENTIFIC STUDY OF THE GROWTH OF CROPS." By A. D. Hall. Pp. xiii. and 286. (Murray.) Illustrated. 3s. 6d.—Agriculture in England is usually practice without science; and agricultural science, on the other hand, often neglects the results obtained by generations of farmers in their fields. Mr. Hall, we are glad to notice, recognises the value of the accumulated experience of the farming community, yet he shows that the study of the soil as a complicated laboratory in which chemical, physical and biological agents are at work, is the only sure means by which tillage operations can be improved. "But," he remarks, "it must not be supposed that science is yet in a position to reform the procedure of farming, or even to effect an immediate increase in the productivity of the land; agriculture is the oldest and most widespread art the world has known, the application of scientific method to it is very much an affair of the day before yesterday." This is the opinion to which every man of science who knows anything of farmers and farming is bound to be led. Mr. Hall's book may only be read by a few people engaged in agriculture, but it is one which every student in an agricultural college should be expected to buy. We know of no volume in which the constitution and work of the soil are dealt with so instructively, for though Warington's "Physical Properties of Soil" is a standard treatise, its scope is not so wide as that of the volume under notice. Mr. Hall is indeed to be congratulated upon his book, which contains many original observations, and is in other respects a noteworthy addition to the literature of agricultural science. We miss, however, reference to Schlichter's memoir on the motion of underground waters, though it contains the results of important investigations connected with sewage in soils.

"CHEMICAL TECHNOLOGY." Vol. IV. Edited by W. J. Dibdin. "Electric Lighting," by A. G. Cooke. "Photometry," by W. J. Dibdin. Pp. xviii. and 378. (J. & A. Churchill.) Illustrated. 20s.—One hundred pages of this book deal with photometry, and in the remainder the various systems, machinery, lamps, &c., in use for the supply of electric lighting are described. The book is not intended for students of physics, or for electrical engineers, but for architects, civil and mechanical engineers, and other professional men who wish to obtain a general idea of the practical side of the subject. Principles are therefore not given so much attention as their applications. At the same time, sufficient consideration is given to scientific theory to enable an intelligent view to be obtained of the construction and working of electrical machinery, the distribution of current, and the determination of candle power. The conditions under which commercial work is carried on differ from those of the laboratory, and the fact that Board of Trade regulations are introduced wherever they bear upon the matter described helps to make the book of real practical value. Of course, it is impossible to obtain an intimate acquaintance with dynamos, storage batteries, electric lamps, photometers, and the like, without actually using them; but anyone who has had the opportunity of studying electrical plant of any kind should have no difficulty in understanding all that the book contains. Photometry, as might be expected, is very well treated, practically every instrument of importance being described. An appendix giving the "Metropolitan Gas Referees' notification of method for testing the gas supplied to London" is of special interest in connection with the competition between gas and electric lighting.

"EXPERIMENTS ON ANIMALS." By Stephen Paget. With an Introduction by Lord Lister. Pp. xvi. and 387. (Murray.) Price 6s.—This book should do a vast amount of good. In its original form it contained many references to misleading comments made by anti-vivisection societies, but these have been omitted, and the book is now a calm statement of progress in medical science, more particularly preventive medicine, from Galen to the present day. Galen, who lived in the second century, made many valuable observations by experiments on animals, but the methods followed by him were not continued by his successors, and though the knowledge of anatomy made progress, physiology remained as Galen left it until the time of Harvey's discovery of the circulation of the blood in 1628. After this came the discovery of the lacteals and of the whole lymphatic system, experimental studies of the digestive processes, the production of bone, and the physiology of the nervous system. The first part of Mr. Paget's book is occupied with the record of these advances. In the second part, experiments in pathology, materia medica and therapeutics are described, and the third part contains a reprint of the Act relating to experiments on animals in Great Britain and Ireland. Modern medical sciences may almost be said to be confined to the second part. Here we have clear and convincing summaries of the work of benefactors of the human race like Pasteur and Lister, and readers who are not familiar with the progress of preventive medicine during the last fifty years will when they have learnt what has been done, bless the men whose work, often carried on against bitter opposition, has enabled us to fight disease intelligently. Consider what has been done to prevent and combat septicæmia, pyæmia, anthrax, diphtheria, rabies, malaria and yellow fever during the last fifty years, and you will obtain a slight idea of the benefits which mankind has received from experimental methods in medicine. Want of knowledge of what has been done is responsible for much of the opposition to the experiments by which the results have been obtained. With Mr. Paget's clear and judicious statement available, there should be no excuse for ignorance, and no want of an answer to those who ask for evidence of the value of experimental medicine.

"VARIATION IN ANIMALS AND PLANTS." By Dr. H. M. Vernon. Pp. ix. and 415. (Kegan Paul.) Illustrated. 5s.—Natural history is becoming a branch of mathematics, and whatever field naturalists may think of the development, there can be no question of the substantial nature of the results obtained in the new department of scientific inquiry. Francis Galton, Karl Pearson, Weldon, and others, have laboriously counted, weighed, and measured animals and plants of various kinds with the view of discovering the character and cause of variation; and an energetic school of biologists—Dr. Vernon among them—has been established in which their methods have been followed with success. In the volume under notice, the principles and results of bio-metric investigations are brought together, and their significance from the point of view of organic evolution is discussed. As an instance of the nature of the material thus studied, Prof. Bumpas's paper on the effect of storm on sparrows may be mentioned. One hundred and thirty-six sparrows were collected after a very severe storm of snow, rain, and sleet in North America, and of these 72 revived, while 64 perished. Measurements of each sparrow were made with the view of determining differences in the characters between the eliminated individuals and the survivors. The results showed clearly that the birds which departed most from the normal type were destroyed by the process of natural selection. Summing up the observations, Dr. Vernon remarks, "The next generation of birds collected in the storm-swept area would accordingly be shorter in length, weigh less, have longer legs, have a longer sternum, and a greater brain capacity than the former generation; supposing, of course, that the variations existing in these characters were partly of blastogenic, and not wholly of somato-

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genic, origin; and this could scarcely fail to be the case." An immense amount of material which lends itself to exact analysis in this way is contained in Dr. Vernon's book, and it all tends to promote the scientific study of variation. The volume is a most valuable contribution to the literature of natural science.

"GEOMETRICAL OPTICS." By Thomas H. Blakesley. Pp. vii. and 123. (London: Whittaker & Co. 1903.) 2s. 6d. net. Illustrated.—Students of optics will find many instructive and original ideas in this book, though the prime object of its publication appears to be a protest against the definition of focal length usually accepted. The focal length of a lens is defined in many books on optics as the distance of the principal focus from the posterior surface of the lens, but this definition is unsatisfactory, and Mr. Blakesley fathers upon it many imperfections of optical instruction, design, and testing. Lenses which have a negative value for their focal length are considered in general as convex lenses, while those which have positive focal lengths are regarded as concave; but these terms are shown to be illogical because "a double convex lens of equal curvatures, if sufficiently thick, will have a positive value for its focal length with the general properties of a concave lens." By measuring distances of object and image from the first and second principal foci instead of the principal points, difficulties are avoided; and simple mathematical forms are developed which are true not only for a simple lens, but also for two or any number of lenses having a common axis. Novel optical experiments are described for determining the positions of the principal foci and the focal length, and formulæ are given, which, with a knowledge of the thickness of the lens, enable all the remaining structural details to be found, namely, the two radii of curvature and the index of refraction. The book should be the means of increasing the precision with which optical details are measured and expressed.

"NATURAL LAW IN TERRESTRIAL PHENOMENA: A RECORD OF EVIDENCE." By William Digby, C.E. Pp. xlv. and 370. (London: W. Hutchinson & Co.) Illustrated.—No useful purpose would be served by a detailed criticism of this book, so we will briefly describe the chief points put forward, for whatever we might say concerning the theories described would be regarded as opposition which traditional schools of scientific thought present to novel ideas from laymen. The book contains a detailed statement of Mr. Hugh Clements's theories and predictions relating to weather and other terrestrial phenomena. "I believe," says Mr. Digby, "that the succeeding pages of this book prove that the moon's attractive influence exerted upon the earth's atmosphere, in conjunction with the sun, accounts, in the main, for all weather phenomena." For particular positions of the moon and sun jointly, certain conditions of weather are prescribed, so that weather prediction becomes an easy form of study of orbital movements. To avoid misrepresentation we quote from the formula upon which Mr. Clements bases his forecasts. "Thus it follows that barometric pressure, increase or diminution of clouds, much or little sunshine, an overplus, an average, or a scanty supply of rain, earthquake-shocks, volcanic eruptions, will all occur in time to come as they did in times past, so long as, in the case of shocks and eruptions, weak spots remain in the earth's crust." It would be easy to offer objections to many parts of the argument upon which this conclusion is based, but we will confine ourselves to one point. It is that human interference is a factor which makes it impossible to reduce weather prediction to the mechanical conditions described. A man drops a lighted match on a dry prairie, or leaves the smouldering embers of a fire in a forest. A great conflagration occurs which may disturb the atmospheric currents for hundreds of miles. It is impossible for Mr. Clements or any other meteorologist to predict the effects of this and similar disturbing causes. But Mr. Clements may rest assured that if his theories are true they will survive scientific opinion; if, however, as we think, they are unsound, they will eventually be relegated to the limbo of the paradoxers.

"VOLCANIC STUDIES IN MANY LANDS." By Tempest Anderson, M.D., F.G.S, etc. (Murray.) 21s. net.—Dr. Anderson is so well known as a photographer of and student of volcanic forms that this handsome book cannot fail to meet with a hearty welcome. Readers of Geikie's "Ancient Volcanoes of Great Britain" and of Bonney's "Volcanoes" are already familiar with his work, and, through Dr. Anderson's courtesy, we were enabled to reproduce two of his recent photographs of Mont Pelée in KNOWLEDGE for last November. The present volume is the result of expeditions made during the last eighteen years to Vesuvius and Etna, the Eifel and the Auvergne, the Lipari Islands, the Canary Islands, Iceland, and the West Indies, as well as to various regions in Britain and North America, in which volcanic action has for long ages been extinct. It contains more than a hundred plates, each accompanied by a short description. The photographs from Iceland, Rhenish Prussia, and St. Vincent are, perhaps, of exceptional interest; but the whole series is unrivalled in the illustrations it affords of the various details of volcanic structure.

"TSIMSHIAN TEXTS."—From the Smithsonian Institute we have received a copy of a volume (No. XXVII.), of the *Bulletin* of the Bureau of American Ethnology, devoted to the elucidation of the so-called Tsimshian Texts, by Mr. F. Boas. Although the transcript of these texts is doubtless of much interest and importance to the students of folk-lore, it is not of a nature to attract the majority of our readers. We must therefore pass over the volume with this bare mention.

BOOKS RECEIVED.

British Rainfall, 1902. By H. Sowerby Wallis and Hugh Robert Mill, D.SC., LL.D. (Edward Stanford.) 10s.

The Junior Arithmetic. By R. H. Chope, B.A. (University Tutorial Press, Limited.) 2s. 6d.

Sand-Buried Ruins of Khotan. By M. A. Stein. (T. Fisher Unwin.) 21s. nett.

A Short Manual of Analytical Chemistry. By John Muter, PH.D., F.R.S.E., F.I.C., F.C.S. (Baillière, Tindall & Cox.) 6s. nett.

The Structure of the Nucleus. By Carl Barus. (Smithsonian Institution.)

Etude Sur L'Appareil Circumzénithal. By Fr. Nusl et Josef Jan Frič. (L'Académie des Sciences de L'Empereur François Josef I.)

A Brief Course in Qualitative Chemical Analysis. By John B. Garvai, B.S. (D. C. Heath & Co.) 3s. 6d.

Elements of Physics. By Fisher and Paterson. (D. C. Heath & Co.) 2s. 6d.

Ways of the Six-Footed. By A. Botsford Comstock. (Ginn & Co.) 2s.

The Truth about the Egypt Exploration Fund. By William Copley Winslow, D.D., D.C.L., LL.D.

Meteorological Observations made at the Perth Observatory and other places in Western Australia, under the direction of W. Ernest Cooke, M.A., F.R.A.S., Government Astronomer. (W. A. Watson.)

An Introduction to Botany. By Wm. Chase Stevens. (D. C. Heath & Co.) 6s.

Elementary Physiology and Hygiene. By Buel P. Colton, M.A. (D. C. Heath & Co.) 2s. 6d.

Lectures and Essays. By Professor Tyndall. (Watts & Co.) 6d.

The Insect Folk. By Margaret Warner Morley. (Ginn & Co.) 2s.

Higher Criticism as Applied to Itself. By Artemus Longsides, M.A. (Authors and Booksellers Co-operative Alliance, Limited.) 1s.

Radiant Energy and its Analysis. Illustrated. By Edgar L. Larkin. (Baumgardt Publishing Company.)

Astronomy for Everybody. By Simon Newcomb, LL.D. (Isbister & Co.) 7s. 6d.

A Naturalist's Calendar. By Leonard Blomifield. Edited by Francis Darwin. (C. J. Clay & Sons.)

The Popish Plot and its Newest Historian. By the Rev. John Gerard, S.J. (Longman, Green & Co.) 6d.

The Reliquary. By J. Romilly Allen, F.S.A. (Bemrose & Sons, Limited.) 2s. 6d.

The Burlington Magazine. No. 5. (Savile Publishing Co.) 2s. 6d.

Nurses and Nursing, or How not to do it. By Sister Medicatrix, Ex.-N.S. (The Authors and Booksellers Co-operative Alliance, Limited.) 6d.

Booklet on *Goerz Trieder Binoculars.* C. P. Goerz. Free.

Water and Air, or New Thoughts on Old Subjects. By J. P. Sandilands, M.A., T.C.D. (The Authors and Booksellers Co-operative Alliance, Limited.) 4d.

Das Zeisswerk und du Carl-Zeiss-Stiftung in Jena. By Felix Auerbash. (Gustav Fischer.)

List of Second-Hand Instruments. C. Baker. Free.

Urban Film Subjects. The Charles Urban Trading Co. Free.

Quacks and What they do. By One of Them. (Authors and Booksellers Co-operative Alliance, Limited.) 6d.

The Wellcome Physiological Research Laboratories. (Walter Dowson, Director.)

Geological Rambles in East Yorkshire. By Thomas Sheppard, F.G.S. (A. Brown & Sons, Limited.)

THE STRUGGLE FOR EXISTENCE IN SOCIOLOGY.

By J. Collier.

II.

The Marital Struggle.

At a date beyond the oldest history, for we find traces of the division in all but the lowest peoples, the "order" of the family split into two great genera, which MacLennan happily named endogamy and exogamy, or marriage within the clan (not the tribe) and marriage without the clan. The struggle between the two is the tragedy of barbaric races. It leads incessantly to war among them, as it led to war in ancient Troy, and as it has led to war in modern Morocco within the last few years. All through the European Middle Ages the two forms battled against one another. The Greek Church upheld, and still upholds endogamy, by permitting marriage between uncles and nieces. The Catholic Church ensured the victory of exogamy in Western Europe by refusing permission to marry wherever the most distant relationship could be traced between the parties. Some of the most questionable acts of the Papacy were done in avowed defence of the principle, and the most frivolous pretexts were accepted for dissolving marriages of royal persons between whom some relationship was alleged. Yet it has more than once yielded to endogamy by celebrating the marriages of uncles and nieces, as not long ago of an Italian royal duke and his niece.

Under Protestantism, which breaks down many barriers, endogamy has recovered some of its lost ground. Cousins may lawfully intermarry, though the scientific battle rages round the point of prudence. Still, a wholesome exogamy remains everywhere the conquering type, and in our own days it has received a new extension through the marriages of the daughters of American millionaires to European noblemen. Endogamy survives or survived in spots or spheres removed from the action of natural selection; in out-of-the-way villages, in fishing and mining quarters of towns, and on thrones, as on those of the Ptolemies and the Braganza.

Exercising the privileges of an Englishwoman in the middle of the eighteenth century, Lady Mary Wortley Montague gained access to the harems of Constantinople, and let in the light of day upon Oriental wedlock. A century later the Princess Belgiojoso revealed the mingled squalor and animalism of the Anatolian harem. A few years ago a French cosmopolite, C. de Varigny, described courtship, marriage, and divorce in the United States as an anthropologist might describe the manners and customs of a strange people. These are the two extreme forms of the marital relationship; is it credible that there can be any genetic connection between them? Yes, the one is the remote ancestor of the other, and between the two—between incestuous polygamy, as lately practised in Salt Lake City, and the purest monogamy, as observed in neighbouring Denver—there is an unbroken chain of descent, of which almost every link can be discovered. Indeed, most of the intermediate species and varieties are our contemporaries, and an inclined plane would let the sociologist easily down from Boston to Bassorah.

Thus, the Bosnian Mussulman, who is pure Sclave, has yet his separated harem, where his one wife lives sequestered. The Greek woman is still rarely seen on the streets; commerce is hampered because she cannot become a shop-assistant; the harem has disappeared, but the husband's Oriental jealousy remains. The status of the upper-class Spanish woman is stamped with Orientalism, though the cigar factories at Seville are filled with girls and women. French marriage reveals its barbarous origin in the universal dowry, the requisite consent of the parents, and their choice of the bride. The English wife is, in the middle and upper classes, almost her husband's equal. The Australian and New Zealand wife, who has a vote for Licensing Committee, County Council, State, and Commonwealth, has the equality and something more that derives from a time (only now passing away) when her small numbers permitted her to make her own terms. The North American wife is a queen, whom over-chivalrous laws are converting into a sultana.

All these varieties and species are constantly (in a sense) at war with one another. Thus (to take a present-day instance), the controversy between the Bishop of London and his Chancellor represents the struggle between the sacred and the secular types of marriage. When the Bishop of London announces that he will visit no church where divorcees are remarried, he commits an act of war against the type of marriage legalised by the State. Great part of the Anglican clergy, both in England and the colonies, is thus at war with the State.

In the United States, the struggle among the many varieties is reflected in the legislation of the States. The prosperity of a State depending on the increase of its population, and emigrants having usually an independence of character that will brook few restraints, each State seeks to attract settlers by abolishing formalities, simplifying all social acts, and especially by facilitating both marriage and divorce. Hence a conflict of laws extending over the entire territory of the Union. According to the State he resides in, a man is married to a woman or divorced from her, married to a woman or never married to her at all. In virtue of the practice of "limited divorce," a woman may be receiving alimentary allowances from two or three former husbands, while she is living with a third or fourth. The way in which a man, without his intention and by some innocent act, becomes, in Persia, the legal husband of a woman, is a subject for comedy, in certain American States it may be matter of tragedy, and in any case it is part of the written law.

A new species of marriage comes in like a new species of plants or animals. A high authority, the late Lewis Morgan, who naturalized himself as an Iroquois in order to study the development of the Indian family, believed that the passage from one domestic type to another was effected by means of a "reformatory movement." The most normal evolution is never quite regular; even the growth of a language takes place by disruptions and breaches of continuity, and the history of the family reveals many a struggle. But if it is implied that, once upon a time, some one individual or some group, perceiving the disadvantages of the old and the advantage of a new type of marriage, deliberately introduced a new system, the view must be pronounced anti-evolutionary. A modern instance is typical. The first man who married his deceased wife's sister was the progenitor of a new variety. A few slowly followed his example. The old type showed fight by inflicting on them a social ban so severe that many women refused to marry their deceased sister's husband. As the numbers of the innovators grew, they gained friends, and a Bill was introduced into Parliament. After a succession of battles it was carried in the Commons; had it been carried in the Lords, the new variety would have conquered, and such marriages would have become numerous. In the British Colonies, where the forces of resistance are far feebler, the struggle was brief, and the old type was defeated along great part of the line; though Anglican and Catholic priests may for a time refuse to recognize it by refusing to celebrate such marriages. It is the history in a nutshell of the rise of polyandry, polygamy, and monogamy.

XUM

The Agrarian Struggle.

In many countries the tenure of land has been the theatre of a conflict. It would be interesting to follow, for example, the vicissitudes of the battle in France during the nineteenth century between *métayage* and *fermage*, or of that other battle between large estates and peasant properties; but either topic would lead us too far afield. A more manageable subject, of more pressing interest and susceptibile of exact statement, invites attention.

By the right of eminent domain, by purchase or confiscation, the Government of a new colony acquires the fee-simple of whole territories. How shall it dispose of them to eager settlers? It sells them to those rich enough to buy, but many eligible farmers lack sufficient means. Then springs up in rapid succession a variety of tenures whose primary object is to facilitate settlement. That the struggle for existence among sociological species arises from the same cause as the struggle among biological species—the number of forms competing in the same area—appears from the fact that, if New South Wales has flowered into sixteen varieties of land tenure, New Zealand luxuriates in nineteen. The experimentation took on a new character after the advent of Henry George. From that moment the disposition was to retain the ownership in the hands of the State, lightly burdening the tenant with a quit rent. The perpetual lease was the first new tenure. Perpetuity might seem to promise as great a duration as a farmer could wish, but the New Zealand land reformer (the Highland shepherd boy who lately died Sir John Mackenzie) stole a march on time and invented the eternal—which its opponents nicknamed the infernal—lease, or lease in perpetuity. The new school holds that the Cosmos is finite, and an eternal lease lasts for only 999 years. Thus, granting fixity of tenure, and carrying with it the power of sale, sublease, mortgage, or disposition by will, it is practically equal to freehold. On the other hand, a low rental of 4 per cent. on the assessed capital value retains the property for the benefit of the State, while a land tax secures for it the "unearned increment." A tenure with all these advantages would seem destined to prevail. Other tenures are accordingly being abandoned in favour of the lease-in-perpetuity. Thus, to take a single instance, in the province of Otago perpetual leases decreased in 1900-01 from 301 to 286, and the area held from 58,538 acres to 55,510 acres. The reduction arose from conversion into leases-in-perpetuity or into freehold. For settlers are manifesting an unmistakable bias in favour of individual ownership. So recently as September last a motion was made in the House of Representatives authorizing the conversion of leases-in-perpetuity into freeholds. The Minister of Lands strenuously resisted the proposal; but the movement shows the tendency of this brand-new tenure to lapse, like the older forms, into freehold. Other evidence is to the same effect. During the year named 195 holders of the old perpetual leases converted their leaseholds into freehold; and the provincial Commissioners testify to the growing popularity of the optional lease systems. Thus, in Taranaki, the occupation-with-right-of-purchase tenure assumes the lead against lease-in-perpetuity by 39 selectors. It is safe to predict that, within a measurable space of time, all tenures will have disappeared, and freehold will reign alone.

Such are the relations among sociological species which the property of language, or the dominance of a particular mode of thought, obliges us to name by terms softened from those descriptive of a bodily encounter. But there is no actual struggle among such species, any more than there are mortal wounds or rivers of blood. Endogamy may be said to die at the hands of exogamy, and State-tenure at the hands of freehold, but only by a questionable extension of a convenient metaphor. Mr. Spencer's felicitous phrase, which even the universal learning of Dr. Garnett attributes to Darwin, more truly describes the result, without always satisfactorily describing the process. It is, indeed, the fittest that survive, but the laws of adaptation remain to be generalized. The world is not a battlefield. Some great new thinker will supply us with a new nomenclature, or will strip our present terminology of misleading associations.

MICROSCOPY

Conducted by M. I. Cross.

POND-LIFE COLLECTING FOR THE MICROSCOPE.

II.—Apparatus for Microscopic Examination.

By Charles F. Rousselet, F.R.M.S.

Having shown in a previous article how to collect the various Pond organisms, I will now discuss those methods of bringing them under the microscope which I have found both practical and expeditious.

Fig. 3 is a photograph of various apparatus used for this purpose, consisting of troughs, pipettes, live box and compressor.

After capturing a miscellaneous collection of Pond-life and transferring it to a window aquarium, placed in front of a window, as previously explained, it will be desirable first of all to place some of it under a low power of the microscope, say a 2 inch or 1½ inch objective, in order to obtain a better general view of the various animals. The free-swimming forms will mostly have collected on the light side of the aquarium, and can there be picked up quite clean, and in vast numbers sometimes

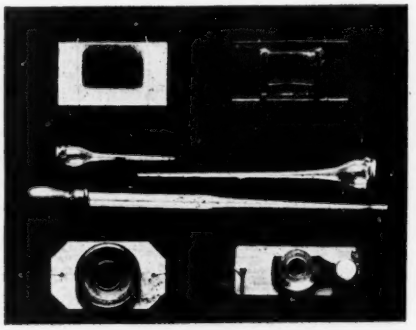


Fig. 3.—Micro. Troughs, Pipettes, Live-box, and Compressor, for Pond-life work.

with the pipette (*e*) and transferred to a square trough (*a*) or (*b*), and placed under the microscope, where the contents can readily be illuminated from below, both with transmitted light and under dark ground. I prefer to use dark-ground illumination with low powers when searching over the contents of a trough, and when studying the shape, mode of swimming, ways of feeding and living of Polyzoa, Rotifera and Infusoria. Moreover, the animals scattered through the trough will soon collect in the spot of light of the condenser, and then the whole field of view will often be a mass of moving, dancing, tumbling, sparkling life.

The trough (*a*), 3 inch by 1½ inch and $\frac{5}{16}$ inch thick, is the form I mostly use; it stands upright on the table, is reversible and can be handled without greasing the well part of the glass. The

sides are cemented in the fire by means of a fusible glass cement, and thus the trough is and remains watertight. The trough (*b*) is also a useful type but it is not reversible, will not stand by itself on the table, and, being cemented with gold size or marine glue, is liable to leak. The troughs usually sold are semi-circular in shape, a very bad type, because in addition to the above defects, the least amount of tilting on the stage will cause the water to run out over the edge. Thicker troughs are objectionable because the substage condenser cannot work through them, and the animals cannot be properly illuminated, though sometimes such troughs may be required by the size and nature of the object.

A few words on pipettes will not be out of place here. The old-fashioned way of using the finger on a straight or curved glass tube to capture Pond-life is so unsatisfactory that I have been driven to invent new pipettes for more precise and exact work. Fig. 3 (*c*, *d*, and *e*) represent the pipettes in constant use. (*e*) is a glass tube about $\frac{5}{16}$ inch in diameter and 8 inches long, which tapers from the middle to a point more or less fine, according to the size of the animals one wishes to capture. Over the wide end is placed an indiarubber teat, by means of which any single specimen, or scores of animals, can be sucked up with the least quantity of water. (*d*) is another type of pipette, having a still finer action; it is 6 inches long, funnel-shaped at one end, and tapering gradually from the funnel to a fine point; the funnel is $\frac{3}{4}$ inch wide, and covered with an indiarubber membrane. (*c*) is a similar, but smaller and finer pipette, $3\frac{1}{2}$ to 4 inches long, for picking up small Rotifers in a fraction of a drop of water under the dissecting microscope. The slightest touch on the membrane is sufficient to expel or bring in the water, so that one has complete control over the amount of water that is taken up, and there is much less risk of losing the animal one wishes to transfer to the compressor.

The old-fashioned live box with raised tablet, still largely sold with microscopes, is quite useless for Pond-life, for the simple reason that the objects cannot be properly illuminated with the substage condenser. This consideration led me long ago to design the live box (*f*), in which the glass tablet is fixed flush with the brass plate, and is of small size, thus leaving a wide ring all round. This arrangement allows all objects on the tablet to be perfectly illuminated from below by the achromatic condenser, both with transmitted light and under dark ground, and at the same time they can be reached and followed from above with both low and high powers, and oil-immersion lenses, to the very edge of the tablet, and wherever they may wander. For more exact work, when it is desired to hold a single Rotifer between the two glasses and prevent its wandering about, I have devised the compressor (*g*), in which the pressure, and the thickness of film of water, can be accurately regulated by a screw acting against a spiral spring. At the same time, water, or reagents, can be added, if desired, without raising the cover. When properly and well made, this compressor works exceedingly well, and I have had it in constant use for years, but some makers, unfortunately, have introduced variations and so-called "improvements" which just take away some of the essential and useful points. The semi-circular thin cover-glass must be cemented to the underside of the brass ring with a little gold size, so as to be quite firm and rigid, otherwise its action becomes uncertain, and very small objects cannot be held fast, or else are suddenly crushed.

Some more simple apparatus and devices may be mentioned for cases where no live box or compressor is at hand. An excavated glass slide makes a fair live cage; a drop of water containing the animals is placed in the cavity so as to just fill it and no more; another drop of clean water is placed by the side of the cavity, and a clean thin cover-glass is lowered on to that second drop; then, by means of a needle, the cover is slowly pushed across the cavity, which can thus be covered without enclosing an air bubble; the superfluous water is taken up by blotting paper, the cover-glass being held in position by capillary attraction. This forms a good slide for low and medium powers, but not for high powers. Another good temporary slide can be made by placing three small fragments of No 1 thin cover-glass near the middle of a glass slip in form of a triangle; the drop of water containing the animals is placed in the centre, and a clean thin cover-glass is lowered on to the drop so as to rest on the three glass fragments, which prevent the animals getting crushed. If there be too much water it can be removed with blotting paper. Low and high powers can be used on this slide as far as the movements of the animals will permit, but not oil-immersion lenses.

Having thus mentioned some essential and necessary apparatus, I will close with a few remarks on the examination of living Pond-life. The free-swimming organisms, including such forms as *Volvox globator*, collect on the light side of the window aquarium, and can there be picked up in small or large numbers, and quite clean, with the large pipette, and placed in the trough; or any particular species can be selected with the aid of the tank microscope, and taken up with the smaller pipette, and transferred to the live box or compressor in a single drop of clean water, both hands being free for this operation.

The fixed forms, such as Polyzoa, *Stephanoceros*, *Melicerta*, *Floscules*, etc., amongst Rotifers, and *Stentor*, *Carchesium*, *Zoothamnium*, etc, amongst Infusoria, require a little management. If simply placed in a trough, these are often obscured, or incapable of being properly illuminated, by being too crowded, or by part of the weed over or underlying the objects, and also by floating particles in the water. The best result is obtained by trimming, that is by cutting off a very small piece of weed or leaf on which the animal is attached—in a watch glass under the dissecting microscope if necessary—and then transferring it with the pipette to the compressor into a drop of clean water; it can there be arranged with a needle or bristle as may be desired, and after lowering the cover-glass, fixed and held fast, at the same time giving the animal perfect freedom to expand. In this position the animals can be reached with the achromatic condenser from below for transmitted light and dark ground illumination, and also with low and high powers, and even oil-immersion objectives from above.

For Pond-life work the Wenham binocular is decidedly to be preferred to the monocular microscope. It is less tiring to the eyes to look with both eyes, and without strain, and the stereoscopic image gives a very much better idea of the true shape of the animals, though the images are not quite so sharp as with the monocular tube; but this binocular form can immediately be changed into a monocular for high power work, or whenever desired by pushing the small prism out of the way.

The binocular is to be used only with the low powers up to the $\frac{1}{3}$rd inch objective; with higher powers the stereoscopic effect is lost, because the depth of focus, or the plane of distinct vision, is then exceedingly small, and becomes more and more a mere optical section of the object.

A mechanical stage is hardly necessary; for ordinary work, a well-made sliding stage or bar is preferable, and should be provided. Stage clips, of which opticians are so fond, are abominations, and should be consigned to the dust-bin.

Of illuminating apparatus, the Abbé form of substage condenser, achromatic if possible, is the only one that is really useful for all powers, and that need be considered both for transmitted light and for dark ground illumination. It should be provided with an iris diaphragm and an arm carrying a central stop, and then completely replaces all the older substage apparatus—condenser, spot lens, paraboloid, etc. The bull's-eye stand condenser, however, is necessary to render parallel the rays of the lamp flame, but it should be mounted on the lamp, and move about with the lamp, and so as to project an enlarged image of the edge of the flame on to the flat mirror of the microscope for dark ground illumination with low powers.

All apparatus used in the examination of Pond-life—troughs, live boxes, compressors, and pipettes—should always be carefully cleaned and dried immediately after use, and in no case should the water be allowed to evaporate in them. Much trouble will be saved by the observation of this rule, and the apparatus will always be ready for use.

"ULTRA-MICROSCOPICAL" PARTICLES.

The meeting of the Royal Microscopical Society, held on the 17th June last, proved to be the most interesting and successful of the session. It had been anticipated that Lord Rayleigh would have been present to read his paper on "The Theory of Microscopic Vision," but he was unfortunately unable to attend, and the paper was read by Dr. Hebb. The great feature of the evening then became a paper by Dr. H. Siedentopf, a member of the scientific staff of the Jena Glass Works, dealing with the visibility of ultra-microscopical particles, illustrated by several objects arranged in the manner prescribed by him, and demonstrating the subject in a very wonderful manner.

XUM

It has of course long been known that whilst there is a fairly well-defined limit of resolving power—in other words, a *minimum distance apart* beyond which two or more particles or elements of structure cannot be *seen* apart—there is no such limit for the size of the separate particles themselves, at any rate not when they are placed in a strong light against a dark background; for under these conditions the smallness of the reflecting surface of the particles can be compensated for by the brightness of the illumination, in much the same way as minute particles of floating dust become visible in the path of a ray of sunlight through an otherwise shaded room.

The interesting and novel parts of Dr. Siedentopf's paper were those dealing with the methods adapted for carrying this system of rendering minute particles visible, to its utmost limit, and those which resulted in fairly reliable estimates of the actual size of the particles.

The usual dark-ground illumination is not very efficient, for whilst it is easy enough to find a stop which will not allow a single ray of regularly refracted direct light to pass through the microscope, it is impossible to prevent a quantity of scattered light produced by reflection from the mounts of condenser and objective, and by double reflections at the numerous lens surfaces, from reaching the eye and rendering it less sensitive to feeble impressions.

This difficulty Dr. Siedentopf overcame in a most ingenious manner by taking advantage of total reflection. He arranged his condenser (a dry one) at right angles to the optical axis of the microscope, so that its concentrated light entered the slide containing or forming the object, laterally. It will at once be seen that none of this light can emerge into air through the upper surface of the slide, as this would demand a refractive index of 1·414,—lower even than that of fluorite. The light diffused by small particles is therefore the *only* light that reaches the eye, and the latter will therefore be sensitive to its utmost limit.

But it is further necessary to limit the illumination to particles within the limits of depth of focus, as otherwise the light scattered by particles not in focus would form a luminous background; this object Dr. Siedentopf attained by focussing the source of light—generally the electric arc—on an adjustable spectroscope-slide, then focussing the slit in his object.

By the use of this refined method, Dr. Siedentopf was able to prove by direct observation that the beautiful red glass, known as gold-ruby glass, contains small detached particles of gold of extremely small size. By computing the cubic space under observation, counting the particles within that space, and ascertaining by analysis the percentage of gold in the glass under examination, it was found that the particles were equal in weight to tiny cubes of gold having sides equal to from one-sixth to five one-millionths of an inch. Though almost inconceivably minute, the particles are still composed of a great number (at least 10,000, according to Dr. Siedentopf) of molecules. These latter must, therefore, still be considered as invisible.

Very minute particles of other origin were also demonstrated, for instance the flagellæ of certain bacteria, and we may confidently look forward to important additions to our knowledge resulting from an intelligent application of the methods of illumination and of observation devised by Dr. Siedentopf.

One interesting question was not, as far as we are aware, gone into by Dr. Siedentopf, viz., why the gold-ruby glass should transmit chiefly red light; this seems rather puzzling, for thin layers of metallic gold transmit green light. Could the colour arise in a similar manner to the blue of the sky?

RUDIMENTS OF PALPI IN DIPTERA.—It is not generally known that the palpi present on the proboscis of our common house flies, *Musca domestica*, and *Homalomyia canicularis*, are labial, that is to say, attached to the lower lip. The exceedingly minute remains of the maxillary palpi can be made out on the anterior ends of the levers that work the lancet. These parts are embedded in the proboscis, but if a preparation is mounted under pressure, after having had the soft parts cleared away by caustic potash, the levers can be seen through the transparent membrane, and a good "sixth," with careful substage illumination, will show some hairs on the tubercles at the anterior ends. These parts are the stripes and cardines of the inner jaws (maxillæ.) A series of palpi can be seen in different species, from a well-developed hairy organ, protruded through the membrane, to a small embedded bulb, which has lost the few hairs we see in *M. domestica*. This, regarded from the evolutionary point of view, is exceedingly interesting.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NEW COMET.—A pretty bright comet, with nucleus and tail, was discovered by Borrelly, at Marseilles, just before midnight on June 21, in R.A. 21h. 52m. 52s., Dec. S. 8° 10′. The direction of motion was towards N.N.W. On June 30, at 0h. 30m. a.m., the writer, at Bristol, observed the comet, and found it distinctly visible to the naked eye. It had a bright nucleus, and a tail of about ¼ degree flowing to the S.S.W. The comet will be in perihelion at the end of August, and during that month will move from Ursa Major, through Leo Minor into Leo.

Alphonse Borrelly, the fortunate discoverer of this object, achieved distinction as a comet finder a generation ago. He sighted his first comet on 1871, October 12, and found five others during the six ensuing years. With a single exception, all the comets seen during the ten years, from 1868 to 1877 inclusive, were discovered by one or other of the famous comet seekers, Borrelly, Coggia, Tempel and Winnecke.

BROOKS'S PERIODICAL COMET (1889 V.–1896 VI.).—This comet will reach its nearest point to the earth on about August 17, though it will not pass through perihelion until the second week in December. The comet is rather unfavourably situated for northern observers, as it is 27 degrees south of the equator, but it ought to be pretty well seen from stations having a very open, unobstructed view southwards. It is moving very slowly westwards, its place at the end of August being only 5 degrees west from that occupied at the opening of the month. The following is an ephemeris for Berlin midnight:—

1903.	R.A. H.	M.	S.	Declination. °	′
August 11 ...	21	8	20 ...	26	59
„ 15 ...	21	5	7 ...	27	3
„ 19 ...	21	2	0 ...	27	6
„ 23 ...	20	59	4 ...	27	5
„ 27 ...	20	56	25 ...	27	1
„ 31 ...	20	54	7 ...	26	53

During this period the comet's distance from the earth will be about 110 millions of miles.

DOUBLY-OBSERVED METEORS.—The real paths of an interesting pair of bright meteors recorded at the April epoch have been computed by Mr. W. E. Besley and by the writer, and the results, placed side by side for comparison, are as under:—

	April 22, 10h. 23m. W. E. B.	W. F. D.	April 22, 12h. 32½m. W. E. B.	W. F. D.
Height at appearance ...	42½m.	45m. ...	75m.	78m.
Height at disappearance ...	26m.	26m. ...	41m.	43m.
Length of path ...	17m.	20m. ...	44m.	49m.
Velocity per second...	5½m.	6½m. ...	35m.	39m.
Radiant point ...	151°+47½°	150°+49° ...	270°+32°	269°+32°
Name of meteor ...	Ursid.	...	Lyrid.	
Observers ...	C. L. Brook, Meltham....		A. S. Herschel, Slough.	
	A. King, Leicester. ...		A. King, Leicester.	

There was also a fine Lyrid observed on April 22, 10h. 36m., by Prof. Herschel at Slough, and Mr. T. H. Astbury at Wallingford. The heights were from 70 to 56 miles over Northamptonshire.

FIREBALL.—Mr. F. L. Raymond writes from Yeovil that on June 30, 8h. 50m., he observed a magnificent meteor. It was white at first, then orange, and moved rather slowly from due S. to a point about 5 degrees above S.E. horizon. The meteor left a short diffused trail, but the exact path was difficult to locate owing to the very strong twilight. The same object was seen by the Rev. S. J. Johnson, of Bridport, who gives the time as 8h. 52m, and says the path was from an altitude of about 15 degrees in due south to about 5 degrees above horizon at a point a little to the eastward. Motion rather slow; duration 3 seconds. Miss Mary E. Glennie also writes from Dinan, France, that the fireball as seen from that place appeared larger than the moon, and emitted zigzag streams of fire as it went along. A sound like distant thunder was heard about a minute after its disappearance. At St. Brieux, France, the bolide passed from W. to E.,

at no great distance above the horizon. At Dawlish, on the Devon coast, the aspect of the meteor was described as splendid, and as appearing under the form of a fiery bolt dropping into the sea.

THE GREAT PERSEID STREAM.—The maximum of this shower will probably occur on the morning of August 13 this year, and observations should be obtained during the nights of the 10th to 14th, if clear, with a view to fixing the hour of greatest abundance. Observers of the display should carefully record the flights of non-Perseids as well as the most brilliant Perseids. But it is scarcely desirable to preserve details of the fainter members of this system, myriads of which have been already recorded during its previous returns.

THE FACE OF THE SKY FOR AUGUST.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 4.24 and sets at 7.48; on the 31st he rises at 5.10 and sets at 6.50.

Sunspots and faculæ may now be observed almost any day; at the time of writing there is a fairly large spot near the central meridian.

THE MOON:—

	Phases.	H. M.
Aug. 8	○ Full Moon	8 54 A.M.
„ 16	☾ Last Quarter	5 22 A.M.
„ 22	● New Moon	7 51 P.M.
„ 29	☽ First Quarter	8 34 P.M.

The moon is in apogee on the 6th, and in perigee on the 21st.

There are no occultations of the brighter stars observable at convenient hours.

THE PLANETS.—Mercury is an evening star in Leo, but is not well placed for observation, as he sets too soon after the sun.

Venus is now very bright, but does not set so late as during the past few months. The planet is at *greatest brilliancy* on the 12th, when the earth is receiving the maximum amount of light from the disc, this point as determined by the celebrated problem of Halley's is when the elongation of the planet is about 40°, the diameter of Venus about 39″, and the enlightened part about 10″. The planet, therefore, at this time appears a little more than a quarter illuminated, and corresponds to the moon when five days old. The point of maximum brilliancy takes place about 36 days before inferior conjunction, hence the planet rapidly approaches the sun towards the end of the month, setting on the 31st about 6.55 P.M. Venus can readily be picked up during the day with a pair of field-glasses, and near the time of greatest brilliancy, having thus once found it, it can frequently be seen with the naked eye. On the 12th the planet is on the meridian at 2.26 P.M., and has an altitude of 36°.

Mars is still observable throughout the month soon after sunset; he is, however, by no means the conspicuous object that he was. Near the beginning of the month he is not far from Spica Virginis, but moves easterly into Libra towards the end of the month. The lustre of the planet is rapidly decreasing, as the apparent diameter is only 6·6″ on the 15th, 0·88 of his disc being illuminated.

Jupiter is again rising sufficiently early that observations may be made before midnight. On the 1st he rises about 9.20 P.M., and on the 31st at 7.15 P.M. Near the middle of the month he is on the meridian at 2 A.M., when the apparent polar and equatorial diameters are 46″ and 49″ respectively.

The most interesting satellite phenomena visible before midnight are as follow:—

Date.	Satellite.	Phenomenon.	Time. P.M.	Date.	Satellite.	Phenomenon.	Time. P.M.
Aug			h. m.	Aug.			h. m.
2	III.	Tr. E.	11 5	18	II.	Tr. E.	9 6
8	I.	Ec. D.	10 36	23	I.	Sh. I.	11 36
9	I.	Sh. E.	10 6	24	I.	Ec. D.	8 54
„	I.	Tr. E.	10 55	„	I.	Oc. R.	11 38
„	III.	Sh. E.	11 24	25	II.	Tr. I.	8 43
„	III.	Tr. I.	11 27	„	I.	Tr. E.	8 49
16	I.	Sh. I.	9 42	„	II.	Sh. E.	10 30
„	I.	Tr. I.	10 22	„	II.	Tr. E.	11 23
„	II.	Ec. D.	10 27	27	III.	Oc. R.	10 55
„	I.	Sh. E.	12 0	31	I.	Ec. D.	10 49
17	I.	Oc. R.	9 53				

Ec = Eclipse. Tr. = Transit. Oc. = Occultation. Sh. = Shadow.
E. = Egress. I. = Ingress. D. = Disappears. R. = Reappears.

Saturn is rather low down in Capricornus. On the 1st he rises about 7.40 P.M., and on the 31st at about 5.30 before sunset. Near the middle of the month he souths at 11 P.M.; his polar diameter is 17″·2.

The northern surface of the ring is visible and the ring plane is inclined to our line of vision at an angle of 19°. The diameter of the outer major and minor axes are 43″ and 14″·3 respectively.

Uranus is low down in Ophiuchus, not far from θ and 44 Ophiuchi (the chart given in the June number enables the planet to be found readily); the disc can be made out with a power of about 100, the diameter being 3″·9. On the 1st the planet is on the meridian at 8.48 P.M., and on the 31st at 6.48 P.M., setting on these dates at about 12.45 A.M. and 10.45 P.M.

Neptune is a morning star, and not observable at convenient hours.

THE STARS.—About 9 P.M. at the beginning of the month the constellations to be noticed are:—

ZENITH . Lyra (*Vega*), Hercules, Draco.
SOUTH . Sagittarius, Scorpio, Ophiuchus, Aquila; Aquarius and Capricornus to the S.E.
WEST . Boötis, Corona; Great Bear to the N.W., Virgo and Libra, S.W.
EAST . Cygnus, Delphinus, Pegasus, Aries; Andromeda and Cassiopeia to the N.E.
NORTH . Ursa Minor, Auriga (*Capella* on horizon).

Minima of Algol occur on the 13th at 10.55 P.M., and on the 16th at 7.43 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of July Problems (P. G. L. F.).

No. 1.

1. Kt to B3, and mates next move.

No. 2.

Key-move—1. Q to K3.

If 1. . . . P to B4, 2. Q to K7ch.
1. . . . P to R5ch, 2. R×RP dis. ch.
1. . . . P to R6, 2. R to B5 double ch.
1. . . . P to Kt6, 2. R×RP dis. ch.

SOLUTIONS received from "Alpha," 2, 4; W. Nash, 2, 4; G. A. Forde (Major), 2, 4; G. W. Middleton, 2, 4; "Quidam," 2, 4; J. W. Dixon, 2, 4; C. Johnston, 2, 4; H. F. Culmer, 2, 4; T. Dale, 2, 4; E. A. Servante, 2, 4; "Looker-on," 2, 4; W. H. S. M., 2, 4.

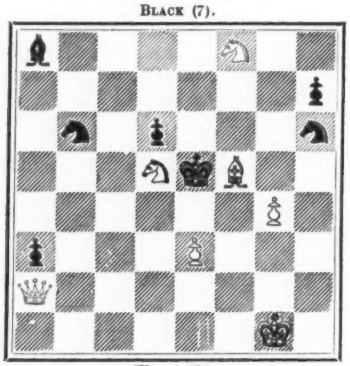
"*Quidam.*"—I cannot find that you were credited with any points for solutions of the May problems, and much fear that your solutions must have gone astray in the post. I have no record of them in my score-book, nor are they mentioned in the proof-slips of the June number which I have by me. But if, as you say, they were acknowledged as correct in that number, you will of course be credited with them. I regret that I am unable to verify this till next week.

W. Nash.—I am afraid I have no idea. Probably the publishers of KNOWLEDGE could give you the information you require.

PROBLEMS.

No. 1.
By W. Geary.

BLACK (7).

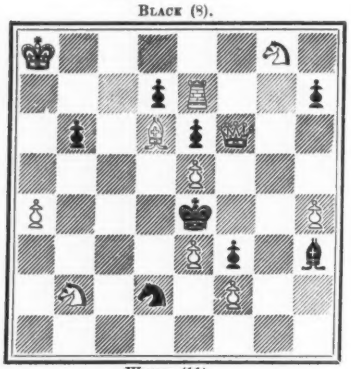


WHITE (7).

White mates in two moves.

No. 2.
By A. Lillie.

BLACK (8).



WHITE (11).

White mates in three moves.

The score of the following game is taken from *Brighton Society*:—

"Queen's Pawn" Opening.

WHITE. C. Schlechter.	BLACK. Dr. Tarrasch.
1. P to Q4	1. Kt to KB3
2. P to QB4	2. P to Q3
3. Kt to QB3	3. QKt to Q2
4. P to K4	4. P to K4
5. Kt to B3	5. B to K2
6. B to Q3	6. Castles
7. Castles	7. P to B3
8. P to KR3	8. Q to B2
9. B to K3	9. R to Ksq
10. Kt to KR4	10 Kt to Bsq
11. Kt to B5	11. B takes Kt
12. P takes B	12. QR to Qsq
13. P to Q5	13. P to QR3
14. R to Bsq	14. Kt (Bsq) to Q2
15. P to KKt4	15. Kt to B4
16. B to Ktsq	16. P to QR4
17. K to Rsq	17. Kt (B3) to Q2
18. P to Kt5	18. P to B3
19. P to KR4	19. B to Bsq
20. R to Ktsq	20. B to K2
21. Q to R5	21. Kt to Bsq
22. R to Kt3	22. R to Rsq
23. B takes Kt	23. P takes B
24. P to Q6	24. Q takes P
25. Kt to K4	25. Q to Qsq
26. R to Qsq	Resigns.

CHESS INTELLIGENCE.

The death is announced of Mr. C. J. Newman, a well-known American player, who has taken part in the last five cable matches against Great Britain. On his first appearance in these encounters he saved most ingeniously what appeared to be a hopeless game.

The first-class Open Tourney of the Kent County Association was won by Mr. G. Shories, of Brighton, with a score of 7 out of a possible 8. The other leading scores were—G. A. Thomas, 5; E. Cresswell and R. Loman, 4½; J. Mortimer, 4.

The Southern Counties' Chess Union holds its annual meeting at Plymouth this year, from August 31st to September 9th. The winner will hold the Amateur Champion Cup, at present in the custody of Mr. R. P. Michell. Intending competitors should address Mr. W. P. Weekes, 7, Sussex Terrace, Plymouth.

Mr. F. J. Marshall has caused some sensation by challenging Dr. Lasker for the championship of the world. It is thought probable that the offer will be declined, on the ground that Mr. Marshall has not yet met with sufficient success to justify the issuing of such a challenge.

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